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A FAST RUN was made recently on the Cleveland, Cincinnati, Chicago & St. Louis Ry. by a special train carrying a theatrical company from St. Louis to Cleveland. The distance is 545 miles. The train left St. Louis at 8.27 a. m., and arrived at Cleveland at 7.45 p. m., or in 11 hours 18 minutes, the running time, exclusive of stops (but including slowing down for crossings and bridges), being 9 hours 55 minutes. The average running speed was 55.38 miles per hour. The greatest speed was attained between Mitchell and Comstock, on the St. Louis Division, where 3.2 miles were made in 2¾ minutes or at 76.3 miles per hour; Gays to Mattoon, 12 miles in 10 minutes or 72 miles per hour. On the Cleveland Division, from Marsh's to La Rue, 3.7 miles were covered in 3 minutes or 74 miles per hour; Wellington to Grafton, 11 1-5 miles in 9 minutes or 69.7 miles per hour. The train consisted of two baggage cars, each 60 ft. long and loaded heavily; two coaches, 70 ft. long, with six-wheel trucks and a parlor car 65 ft. long. There were 73 people on board. The total weight of the train, exclusive of engine, is estimated to have been nearly 200 tons.

THE MILEAGE OF TRACK of the Pennsylvania R. R. system at the end of 1896 aggregated 12,859.97 miles, distributed as follows:

	West of Pittsburg, miles.	East of Pittsburg, miles.	Total, miles.
First track	2,762.41	4,138.26	6,900.67
Second track	508.88	1,180.72	1,689.60
Third track	35.97	359.12	385.09
Fourth track	18.19	256.80	274.99
Company's sidings	1,343.39	2,255.91	3,599.30
Total	4,669.16	8,190.81	12,859.97

THE RUSSIAN RAILWAY IN MANCHURIA, says "Le Genie Civil," is thus referred to in an Imperial ordinance, dated at St. Petersburg on Dec. 23: This ordinance approves of the plans of the East-Chinese Railway Company for the construction and operation of a railway on Chinese territory, extending from the west frontier of the Province of He-Lung Kiang to the east frontier of the Province of Kirin, and for the connection of this line with the Trans-Siberian railway. To carry out this work the East Chinese Railway Company has been organized under the control of the Russian-Chinese Bank. By the terms of the agreement between Russia and China, the life of the concession is fixed at 80 years, and the stockholders of the company must be Russian or Chinese subjects. The company must commence work before August 16, 1897, and they must finish the railway construction within six years.

A NEW CROSSING GATE for grade crossings has been invented by Mr. Fred. H. Nichols, of Lynn, Mass. The gate is of steel, of lattice construction, and moves vertically in a well or slot in the street, its upper edge closing the slot when the gate is lowered. Its weight is counterbalanced.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a derailment of a train on the Paint Creek bridge, near Shippensville, Pa., on the Pittsburg & Western R. R., Jan. 23. The train consisted of an engine, tender, baggage car and two passenger cars, and the entire train went off the structure, which is about 50 ft. high and is on a curve. Three men were killed and another was so seriously injured that he died two days later.—— The cars of an express train on the Intercolonial Ry. jumped the track near Dorchester, N. B., Jan. 26, and went down the bank and into Palmers Pond. The engine did not leave the rails. Two persons were killed and several injured.

A CAR HEATER EXPLOSION occurred Jan. 20 in a pay car of the New York, New Haven & Hartford R. R., at Wallingford, Conn. It is said to have been a Baker heater. One man was hurt.

AN EXPLOSION OF DYNAMITE took place on Jan. 19 at the factory of the Columbian Powder Co., at Shannopin, Pa., on the Ohio river, 19 miles below Pittsburg. Four persons were killed, including the superintendent of the works. A peculiar phenomenon connected with the explosion was that at places only ten miles distant the sound of the explosion was not heard, nor was any shock felt, while shocks were felt at Irwin, Blairsville, and other places 60 or 70 miles away.

A STEAMSHIP BOILER EXPLOSION occurred recently on the French coal steamer "Madeleine" during the voyage from Callao to San Francisco. Five men were killed.

THE FALL OF A FREIGHT ELEVATOR at the building of the Interior Conduit & Insulation Co., 327 W. 24th St., New York city, caused the injury of five men. The elevator was in use to hoist some long pipes which projected above the top of the cage and struck against the roof as the elevator neared the top story.

A FIRE at the headhouse of Shaft No. 1 on the Nashua River aqueduct tunnel, at Clinton, Mass., on Jan. 19, damaged the hoisting plant so that the men in the tunnel were imprisoned for some hours.

A SERIOUS FIRE occurred Jan. 26 at Philadelphia, Pa., which burned over almost the entire block bounded by Market, Filbert, Juniper and 13th Sts. About 60 buildings were destroyed and the property loss will amount to about $1,000,000. No lives were lost.

A GENERAL MISSISSIPPI AND OHIO RIVER BRIDGE bill has been submitted to Congress by Mr. Dalzell. It relates also to bridges over the Monongahela, Great Kanawha, Tennessee, Cumberland and Illinois Rivers. It prescribes that all bridges hereafter erected over the Ohio River shall have their axis at right angles to the current, with all through spans. There must be at least one channel span with a clear waterway of 1,000 ft., at low water, and the channel span must be at least 40 ft. above local highest water, measured at the lowest point, and 90 ft. above low water in bridges built above the mouth of Big Sandy River, and at least 104 ft. above low water in bridges built below that river. On the Monongahela River the channel span is to be not less than 800 ft. wide, with a clear head room of 54 ft. above the surface of any full pool. The channel span on the Great Kanawha is fixed at 500 ft., with 82 ft. clear headway. The bill also requires all designs for such bridges to be approved by the Secretary of War.

A BRIDGE-CLEARANCE INDICATOR is suggested for the Brooklyn Bridge. This indicator would be modeled after those showing the height of the tide, in New York and the Delaware harbors. This is a dial, 30 ft. in diameter, carrying figures, each 3 ft. high, and a pointer connected with a float, and another pointer, at the center of the dial, shows whether the tide is rising or falling. The pointer tells the exact state of the tide and both can be seen, with a glass, at a distance of two miles. In the case of the bridge the pointer would indicate the clearance, in feet, under the structure, and thus possibly save damage to the top-rigging of ships.

THE OHIO RIVER SHIP CANAL PROJECTORS want the $10,000 appropriated by the councils of Pittsburg for the preliminary work, and the committee of the Pittsburg Chamber of Commerce has petitioned the court for a mandamus on City Controller H. I. Gourley, compelling him to issue a warrant for that sum. Mr. Gourley claims that this issue would be contrary to the State Constitution and State laws, which forbid a city to appropriate any money to any corporation, association or individual. He holds that the $10,000 ordinance is illegal; and even if legal, the money could not be paid to the committee, but must pass through the hands of sworn officials of the city, and be paid only upon proper vouchers. Meanwhile the committee has expended about $9,000 on the faith of this ordinance.

THE PHILADELPHIA HARBOR FRONT is to be improved to the extent of $2,000,000 expended, a new loan for that amount being practically assured. Of this amount all but $500,000 is to be applied to widening Delaware Ave., fronting the river. The balance will be used upon the channel. Damages to property to the amount of $616,000 have also been approved and the councils have passed an ordinance appropriating that sum. Delaware Ave. will be widened to 150 ft. and the piers and docks will have to be extended about 100 ft. into the river to the new pier-head line. The new bulkhead wall will be of stone founded on piles.

THE RESUMPTION OF HYDRAULIC MINING in California is probable at an early date. The farmers located along the rivers which have been silted up by the "slickens" from the mines, and who have compelled the miners to abandon hydraulic mining, are now disposed to help the miners to find a solution of the trouble. The means proposed is the construction of dams which will restrain a large portion of the debris from the mines, and dredges to remove the remainder from the rivers. A bill has been introduced into the state legislature appropriating $300,000 for the improvement of the rivers, and the farmers are favoring the bill, and are ready to join the miners in asking additional aid from the general government.

THE TURTLE-BACK REVOLVING TURRETS, recommended by Congressman I. F. Fischer for Romer Shoals, at the entrance to New York harbor, are thus generally described in a memorial presented by Mr. Fischer: The Romer Shoals lie one mile east of Sandy Hook Point and are 4 miles from Coney Island, the next nearest land. There are here 35 acres within the 6 ft. curve of soundings, and the space required for three turrets would not exceed 1,000 × 300 ft., easily filled up by sand pumped inside bulkheads. It is proposed that each turret be protected by an oval chilled iron cover of great strength revolving with the two guns contained within it. With armor of the Gruson type the cost would be small as compared with that of a double-turretted monitor. Each turret would require a crew of but 20 men to operate it, and would practically cost nothing for repairs and maintenance in times of peace. As it would project but a few feet above the water it would be very difficult to hit, and it would be unassailable by torpedoes. Military authorities, however, say that the cost of foundations will be great, and the question of position and range must be carefully considered before definite action is taken.

TWO-STORY TURRETS FOR THE NEW BATTLESHIPS are objected to by Chief Constructor Hichborn, though Chief of Ordnance Sampson prefers them to the elliptical inclined system recently adopted. The Secretary of the Navy sustains Constructor Hichborn, as he, by the naval regulations, is alone responsible for the design and construction of warships.

CIVIL SERVICE EXAMINATIONS will be held as follows by the New York City Civil Service Commission, in the New Criminal Court Building: Feb. 1, attendant for bacteriological laboratory; Feb. 5, chainmen and rodmen; Feb. 8, building inspectors of iron and steel construction; Feb. 11, engineer inspector of regulating, paving, grading, etc.; Feb. 17, building inspectors of masonry and of construction other than iron and steel. Further information may be obtained of the Secretary, Mr. S. W. Briscoe. ——Applications for the positions of inspector of paving and inspector of masonry in viaducts and stone walls will be received until Feb. 1 by Mr. E. B. Lent, Secretary of the Brooklyn Civil Service Commission, City Hall, Brooklyn, N. Y.

A CONVEYOR FOR UNLOADING VESSELS has been successfully tried at Tacoma, Wash., on Jan. 14, in discharging packages of tea, silk, etc., from the trans-Pacific steamer "Tacoma." It is the invention of Chas. Anderson and Wm. McCabe, both of Tacoma. The apparatus comprises a skeleton frame structure 42 ft. long and 4 ft. square, which is lowered to the hold of the vessel and placed at an angle of about 85°. An endless wire cable traverses it from end to end, and to the cable are attached at intervals a series of cross bars. Inside the wires is a board lining parallel to them. The packages are placed on the cross bars, which pull them up the boards, and deliver them to an inclined chute at the top. It is claimed that the machine, when run at full speed, will discharge 4,000 packages per hour.

THE ENGLISH CHANNEL TUNNEL SCHEME is practically and officially dead. At the last meeting of the shareholders of the Channel Tunnel Company it was decided to abandon the project of connecting England with the Continent by a tunnel under the Straits of Dover. The cause stated was the impossibility of inducing the political heads of England and France to unite upon any proposition for a tunnel, and the somewhat foolish antipathy of Englishmen against any measure that would tend to destroy their insular position.

NATURAL GAS FOR SYRACUSE, N. Y., is proposed by the Syracuse Gas Co., by means of a pipe line from wells of which it has acquired control.

WEST BLUFF SEWER SYSTEM, PEORIA, ILL.

By A. D. Thompson, City Engineer, Peoria, Ill.

(With two-page engraving.)

A general system of sewerage designed by Mr. N. R. Gibson, then City Engineer, with Mr. E. S. Chesbrough, of Chicago, as Consulting Engineer, was adopted by the city of Peoria, Ill., in 1878. The sewers in a number of the districts were constructed at different periods, as shown in the general plan, with slight modifications due to the growth of the city, until the Fall of 1893, when it was found necessary for the health of the citizens to dispose of the storm water and sewage in the West Bluff district. This district is the largest and most important in the city, and had developed to such an extent that the original plan was not applicable. Mr. W. C. Parmley, Assoc. M. Am. Soc. C. E., was employed to design a new system under the direction of Mr. Jacob A. Harman, then City Engineer, which design was completed in the Fall of 1894.

The city of Peoria is located on the west side of the Illinois River, the main business portion and most densely populated districts being situated upon the lowlands and extending to the bluffs, which are about 180 ft. above low water and 6,000 ft. distant from the river. The surface of the ground in the sewer district has a gradual rise from the river to a long ridge parallel with and about 4,000 ft. from the river and

Fig. 14.—View of White Sewer Trenching Machine in Operation.

having an elevation of about 91 ft. above low water. Between this ridge and the bluffs lies a long low basin, known as "Goose Lake," with an elevation of only about 74 ft. above low water. This basin determined the depth of the main sewer from the river to this point, and required a maximum depth of 48 ft. through the ridge.

The primary object of the sewers was to provide surface drainage, thus necessitating a combined system, composed of about 22 miles of pipe and 11 miles of brick sewers, giving drainage to 1,100 acres and sewer facilities to 1,025 acres, including a portion of the most densely populated district in the city. The city paid 10% of the estimated cost, and the balance was assessed against the contiguous property. The rate of assessment for the 90% was based upon the area of the district, and amounted to $0.01093 per sq. ft.

Design.—From Mr. Harman's report for 1894, to the City Council, the following data has been obtained regarding the design of the system:

The amount of storm water to be provided for was figured by the formula,

$$Q = c\,r\,\sqrt[4]{\frac{8}{A}}$$

in which Q = quantity of water reaching sewer in cubic feet per second; c = an arbitrary coefficient which ranges from 0.30 for rural districts to 0.75 for paved streets and roofs, assumed at 0.65; r = average intensity of rain during the period of heaviest fall in inches per hour, used as 2 ins.; S = general grade of drainage area in feet per thousand, found to be 3 ft.; A = area drained in acres, = 1,100. Substituting these values the formula becomes,

$$Q = 1.716\,A^{\frac{3}{4}}.$$

The amount of house sewage to be provided for was based on a population of 50 per acre, or 32,000 per square mile, with a maximum amount of 200 gallons of sewage per capita per 24 hours, equivalent to 0.0155 cu. ft. per second per acre. An allowance of 0.01 cu. ft. per second per acre was made for subsoil waters, and the complete formula is,

$$Q = 1.716\,A^{\frac{3}{4}} + .0225\,A.$$

To provide for subsoil drainage in the bluff region, 4-in. tile drains were designed, to be laid on a 1×3 in. board resting on top of the sewers. The sizes of sewers were computed by Kutter's formula, using coefficient n = .015. The minimum slopes adopted for the various portions of the system were as follows: 1 in 250 for lateral sewers; 1 in 300 for sub-mains; 1 in 400 for main sewer.

For sizes from 6 ins. to 20 ins., inclusive, vitrified pipe were used; from 1 ft. 6 ins. by 3 ft., to 4 ft. 6 ins., inclusive, egg-shaped brick sewers were used; from 42 ins. to 88 ins. in diameter, inclusive, circular brick sewers were used.

The following thickness of walls was used in brick sewers: Circular—42 ins. to 66 ins. in diameter, inclusive, 8 ins., or two rings of brick; 68 ins. to 88 ins. in diameter, 12 ins., or three rings of brick. Egg-shaped—18 ins. to 24 ins. transverse diameter, inclusive, 4 ins.; 26 ins. to 30 ins. transverse diameter, inclusive, invert 6 ins., arch 4 ins.; 32 ins. to 34 ins. transverse diameter, inclusive, 8 ins.

The form for egg-shaped sewers was Baldwin Latham's improved form, with the following dimensions expressed in terms of the transverse diameter: Vertical diameter, 1½; radius of the sides, 1⅛, and the radius of the bottom, ⅛. The thickness of walls and the forms of the brick sewers are shown in Fig. 1. Direct untrapped inlets are used for storm water, and ventilation is secured through these inlets and perforated manhole and lamphole covers.

Contract Prices.—The contract for this system was let in April, 1895, to the T. B. Townsend Brick & Contracting Co., of Zanesville, Ohio, at the prices shown in the accompanying table.

Flush Tanks.—Flush tanks were provided in the design at every dead end, regardless of the size of the sewer. The flushing device was specified to be equal in quality to the Miller pattern, and the Rhoads-Williams siphon was accepted and used. Of the 185 tanks estimated, 131 were to be 4 ft. in diameter, with a 6-in. siphon and a discharging capacity of 145 to 165 gallons of water, and 54 were to be 4½ ft. in diameter, with an 8-in. siphon and a discharging capacity of 230 to 240 gallons of water. The regular form of flush tank is shown in Fig. 2.

Of the large tanks shown on the plans, 34 were omitted in the construction. The tanks thus omitted were designed to flush brick sewers which had storm water inlets connected at the dead ends, as well as at various points along the line, and it was considered that the tanks under such circumstances would not prove of sufficient benefit to warrant the expense of construction, operation and maintenance. Twenty tanks of the large, and 134 tanks of the small size were constructed.

The combination manhole and flush tank, shown in Fig. 3, was designed for use at the dead end of large sewers. This form requires a depth to the bottom of tank of at least 8 ft., for a proper construction, while the depth of many of the large sewers at the dead ends was from 6 ft. to 7 ft. After constructing three in the above manner, the form was changed to that shown in Fig. 4, which requires 1 ft. less depth and is much stronger. The principal objections to the original form were the greater depth required, the possible weakness of the arch over tank, as it is 16 ins., or less, under the surface, and the difficulty of access for examination or repairs.

Manholes.—Manholes were placed at all sewer junctions and at intervals along the sewers not exceeding 400 ft. in length. They are oval in form, being 3×4 ft. inside measurement on brick sewers, and 4 × 5 ft. on pipe sewers, with a 6-in. concrete bottom and 8-in. wall. The bricks in the inside ring were laid alternate headers and standers. Fig. 5 illustrates the form of manhole on pipe sewers, with cast iron covers for same.

Lampholes.—Lampholes were placed on pipe sewers at every change of grade between manholes and at each dead end. They are 8 ins. in diameter, with a perforated cast iron cover resting on a concrete base 6 ins. thick and 2 ft. square. Fig. 6 illustrates the form of lamphole and casting.

Drop Inlets.—The drop inlet at manholes where the flow line of the lateral is above the flow line of the main sewer has been used in a great many cities, and was designed for this system where the difference in elevation of the two grade lines exceeded 18 ins. Such construction was not considered safe, and it was abandoned on all sewers excepting the 8-in. pipe lines. The drops on these lines were strengthened by a concrete ring 6 ins. in thickness around the vertical pipe extending from the bottom of drop to the inspection pipe, and resting upon a concrete base of the same thickness beneath the curve, as shown in Fig. 7. The object of this concrete was to support the vertical pipes and relieve them from the pressure of the earth, and also to support the first length

Fig. 15.—View of Moore Sewer Trenching Machine in Operation.

of pipe in the sewer which was laid on filled earth. Even with this precaution, the stability of the drop is doubtful, as the final inspection has shown several with broken joints, due to settlement, and others with broken curves and pipes. The curve at the bottom appears to be the weakest point in this construction. This curve was found to be broken in a majority of the failures noted, many of which showed no evidence of settlement, thus indicating that the curve was not sufficiently strong to support the weight of the pipes above.

In pipes of greater diameter than 8 ins., and in brick sewers, where the difference in grade elevation has been considerable, the connection has been made in some instances by lowering the grade of the laterals to the grade of the main line at the manhole, the drop being taken up by a steep slope not exceeding 10%, placing a lamphole for inspection purposes where the regular grade was intersected, as show in Fig. 9. In other instances with pipe sewers a brick drop has been constructed outside the manhole, as shown in Figs. 7 and 8, and has proved a desirable form. A special connection between a shallow and deep sewer, with about 16 ft. difference in elevation of flow lines and a distance of 16½ ft. between the sewers, is shown in Fig. 10.

Storm Water Inlets.—Direct, untrapped storm water inlets were used, consisting of a casting of the form shown in Fig. 11, with a 10-in. pipe leading to the sewer. Nothing in the plans or specifications indicated how the casting was to be supported, or the manner and depth of connecting with the sewer. Where manholes were provided,

the inlet pipe has been connected at the manhole at a depth of 10 ft. to 12 ft. below the surface. Where no manholes were provided, it was the evident intention to make direct connection with the sewer, and pipes were placed in the sewers at several points for such purpose. This proved to be impracticable on deep sewers, because the pipes thus placed and extended for 8 ft. or 10 ft. when the sewer was constructed were upon examination later found to be invariably broken, some transversely and others laterally, and a double ring brick stand pipe 2 ft. in diameter was constructed from the brick sewer to the surface of the ground, and the storm water inlet pipes were connected in the same manner as into a manhole. Manhole castings were placed on top of these stand pipes at the surface of the ground, so they would be accessible for examination. Granite blocks have been used on the inside bottom ring of the sewers, where the storm water drops were constructed, as shown in Figs. 7 and 8. They were also placed at the junctions of large sewers.

House Connections.—Slants and Y's 6 ins. in diameter were placed in the sewer for future house connections every 20 ft. On sewers more than 15 ft. deep, ⅛ curves, supported by bricks, were built into the crown of the arch in brick sewers, while on pipe sewers the curve was connected with the Y's turned on top. On this elbow a 6-in. stand pipe was constructed to within about 12 ft. of the surface, the top length of pipe being a pair of breeches, so that a connection could be made from either side. These stand pipes are illustrated in Fig. 12.

Materials.—The bricks used in the construction were second pavers, and were exceedingly hard and tough. The very hard-burned, smooth brick were at first rejected, for fear the cement would not adhere to them, but a few experiments showed the strength of masonry constructed of the hard smooth bricks to be apparently as great as that made from the softer ones. No bricks were allowed in any portion of the work which absorbed more than 12% of water, and a large majority of the bricks used absorbed from less than 1% to 5%.

Utica hydraulic cement, from Utica, Ill., was used on the entire work, mortar for pipe joints being mixed 1 to 1, and for brickwork 1 to 2, with concrete composed of 1 part cement to 2 parts sand and 5 parts broken stone. The cement was required to fill the following specifications:

All cement shall be what is commonly known as American natural hydraulic cement, of quality equal to the best obtainable in the markets. It will be subject to rigid inspection, and must be able to stand the following tests: Two cakes, 3 ins. in diameter and ½-in. thick, with thin edges, will be made. One of these cakes, as soon as set, will be placed in water and examined from day to day. If the cake exhibits checks, cracks or contortions, the cement will be rejected. The other cake described will be used for setting and color tests. The time will be noted when the cake has become hard enough to sustain a wire 1-12 in. in diameter loaded with ¼ lb. When the wire is sustained, the cement has begun to set, and this time shall not be less than 30 minutes. When the cake will sustain a wire 1-24 in. in diameter, loaded with 1 lb., the set is complete, and this time must not be less than 1 hour, nor more than 3 hours. The cake used for setting test will be preserved, and when examined from day to day must be of uniform color, exhibiting no blotches or discolorations. The cement must be evenly ground, and when tested with the following standard sieves, must pass at least the following percentages:

No. 20 sieve, having 20 meshes per lin. in..... 100%.
No. 50 sieve, having 50 meshes per lin. in..... 90%.
No. 74 sieve, having 74 meshes per lin. in..... 80%.

The diameter of wire for the sieves being respectively:

For No. 20 sieve, No. 28 Stub's wire gage;
For No. 50 sieve, No. 35 Stub's wire gage;
For No. 74 sieve, No. 37 Stub's wire gage.

All cement for test briquettes, whether to be used neat or with sand, will be mixed with barely sufficient water to make a stiff dough or mortar. The sand for cement tests will be of such fineness that all will pass a sieve of 20 meshes per lin. in., and none of it a sieve of 30 meshes per lin. in. It will be the best quality obtainable of washed river sand. The required tensile strength per sq. in. shall be as follows: Neat cement, one day, till set in air, remainder of time in water, 60 lbs.; one week, one day in air, six days in water, 100 lbs. Cement, 1 part, and sand 2 parts; one week, one day in air, six days in water, 65 lbs.

Spreading of Sewer.—The sewer empties directly into the Illinois River, and is constructed for about 200 ft. through a filling of cinders several feet deep. The top of the sewer at this point is about ten feet beneath the surface, and these cinders having been filled in for several years were considered sufficiently solid by the designers to make a firm foundation for the sewer and resist the outer thrust of the arch, but as a precautionary measure a bed of concrete 8 ins. thick was placed beneath the sewer, extending around the sides about one-third of the distance to the springing line. The cinders allowed some spread at the springing line, however, as was evidenced by longitudinal cracks in the crown of the arch and center of invert. For a distance of 68 ft., where the sewer passed under a railway, the continual jarring of the cinders by trains passing over them caused the arch to spread to such an extent that bricks fell out of the inside ring of the crown. This defect was remedied by removing three rows of brick from the three rings in the crown of the arch and relaying them, while further trouble of the same nature was prevented by placing a concrete support on each side of the sewer. This support is 2 ft. wide at the narrowest point, and extends from a point 15 ins. below to a point 21 ins. above the springing line, as shown in Fig. 13.

Tunneling.—The contractors intended to construct a mile of the main sewer by tunneling, as the specifications permitted construction by this method, instead of open trenching, on any work 20 ft. or more in depth. The portion of the work which was to be built in this manner extends from near the river through the ridge previously mentioned, the depth varying from 20 ft. to 48 ft. with a brick sewer from 64 ins. to 88 ins. in diameter. The material encountered was a fine dry sand, and after a trial of several weeks with the ordinary poling method of tunneling, the attempt was abandoned as impracticable, because of the difficulty in holding so large a sand face. A contract for the tunnel work was later sublet to Sinclair & Co., of Chicago, who used the English system of driving a small heading at the top and extending it sidewise and downward, the roof and sides being supported by poling boards and crown bars. They were fairly successful for a time, but the contract was abandoned after five weeks' work. During the present season, tunneling by the method first attempted, without the small heading, was successfully operated in the same material on about 1,100 ft. of sub-main, 64 ins. in diameter and from 30 ft. to 48 ft. in depth. The rate of progress averaged from 10 ft. to 12 ft. per day, working 20 hours.

Character of Soil.—The main sewer from the river to the "Goose Lake" district was constructed in open trench, after the tunneling was abandoned, at considerable extra expense, the material from top to bottom being a fine, dry sand, which required close sheeting and careful work. The "Goose Lake" district consists of a basin about 23 ft. in depth lying between the ridge and bluffs and was formerly a large lake or swamp. The material encountered consisted of a bed of gravel and sand about 14 ft. thick, overlying an impervious clay containing numerous sand pockets. The water from the bluffs flows through a vein of gravel to this basin, where it is impounded, and constant pumping was required from sumps to which the water was carried by pipes laid beneath the sewer.

The sand pockets in the clay were filled with water and a mixture of sand and clay, which was worked into a semi-fluid condition by the movements of the laborers. The depth to solid clay was generally from 1½ ft. to 3 ft., and as this soft material would not support the weight of the sewer it became necessary to construct a foundation for it. The foundation was formed by filling the pocket to within about a foot of the subgrade of the sewer with waste stone, the top foot of filling being made with concrete laid dry and well tamped. Throughout this district and on portions of the bluff where water was encountered a 2-in. gas pipe was built at intervals into the brickwork, and extending through it to allow this subsoil water to enter the sewer. The end of these pipes outside the sewer was surrounded by a pocket of broken bricks to prevent clogging.

The material on the bluffs generally consisted of a bed of yellow clay about 14 ft. in thickness resting on gravel. No especial difficulty was encountered in constructing the sewer in this region, although the water at times was a source of delay and annoyance.

Trenching Machines.—The trenching and back-filling on the main sewer, and a majority of the sub-mains, was done with trenching machines, one White, one Moore and two Adams excavators being in constant use.

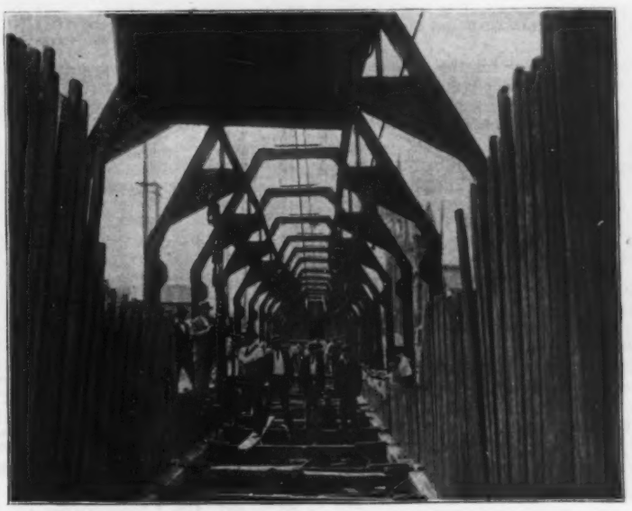


FIG. 16.—VIEW OF ADAMS SEWER TRENCHING MACHINE IN OPERATION.

The White trenching machine is illustrated in Fig. 14. The photograph of which this is a copy was taken when the trench was being started, and the dirt was hauled away on wagons, there being no place for back-filling. In the proper operation of the machine, the small buckets are filled and dumped into the hoppers on platform, which in turn are emptied into a side dumping car running on a track parallel to the trench. This car is hauled back to the completed sewer by a mule, and the material used to back-fill. This machine was found to be very effective and economical on trenches from 5 ft. to 8 ft. in width and from 10 ft. to 20 ft. in depth. In such trenches it was much cheaper than hand work. The first four or five feet of trench was always excavated by hand. The machine was also used to advantage on curves and short lines, where it was impossible to set up the larger excavators. In sand or gravel about 125 cu. yds. were handled per day, with the following men: Six men trenching, one engineer, two men dumping and lowering buckets, one driver and one man with driver to dump car.

The Moore and the Adams machines operate as conveyors, with an overhead track. Their method of operation is shown in Figs. 15 and 16. The

Adams trenching machine is a new excavator designed by Adams Bros., who were partners in the contract and superintendents of the work, and it was used for the first time in this work. The car carrying the bucket travels above the track and trestle in the Moore machine, while in the Adams the track for the car is supported by gusset plates within the trestle, and the bucket with a small platform in the rear is carried beneath the track. By operating the car on a track beneath the trestle there is a clear, unobstructed space beneath the entire length of the track, and the cable operating the car can be attached to a plow or scraper to assist in excavating, or it can be used for moving timbers. This arrangement of the bucket required but one man to operate, while two are necessary with the Moore excavator. An 8-in. I beam is attached to the lower edge of the gusset plate, as shown in Fig. 17, upon which a traveler is operated carrying a steam hammer for driving and an attachment for pulling the sheeting. The three holes in the gusset plate allow the position of this girder to be changed to suit the width of trench, and bring the hammer and sheeting puller directly over the line of sheeting. An engine at one end furnishes power for operating the car and moving the trestle, and one at the other end furnishes the power for driving and pulling sheeting. The form of trestle allows the machine to be moved forward without driving the sheeting close to the ground, which is impossible with the Moore machine.

Mr. A. W. Gates, Engineer for the contractors, has given the following data on the cost of excavating and sheeting:

Cost of Sheeting.—On a trench 45 ft. deep, 13 ft. wide, sheeting 16 ft. long, the cost of setting, driving, pulling and moving sheeting and timbering by hand was as follows:

2 timber men on top, at $2.00	$4.00
2 men setting, at $2.50	5.00
8 men driving, at $1.50	12.00
8 men pulling, at $1.50	12.00
2 men moving lumber ahead, at $1.50	3.00
Total	$36.00

This force sheeted 12 lin. ft. per day, on an average, at a cost per foot of $3.00.

The cost of the same work under the same conditions, using an Adams trench machine with steam for driving and pulling the sheeting, was as follows:

2 timber men on top, at $2.00	$4.00
2 men setting, at $2.50	5.00
1 man operating driver	2.00
2 helpers, at $1.50	3.00
1 man pulling	2.00
2 helpers, at $1.50	3.00
1 engineer	2.00
1 man moving lumber ahead	1.50
Coal, oil, steam-hose and repairs	2.50
Total	$25.00

Twelve lineal feet of trench were timbered per day at this cost, or $2.08 per lin. ft. The saving in cost of sheeting on a trench of this size by the use of steam in driving and pulling was 92 cts. per lin. ft., in addition to the fact that the wear on sheeting driven by this method was much less than when it is done by hand.

The following cost of sheeting is for hand work, trench 35 ft. deep, 12 ft. wide:

2 timber men on top, at $2.00	$4.00
1 man setting	2.50
6 men driving, at $1.50	9.00
4 men pulling, at $1.50	6.00
1 man moving lumber	1.50
Total	$23.00

Thirteen lineal feet of trench were sheeted per day at a cost of $1.77 per lin. ft.

Small trenches 8 ft. to 16 ft. deep in sand cost from 10 to 25 cts. per lin. ft. to timber, 2×8 ins. hemlock being used for sheeting. Stringers in trenches 35 ft. or more in depth were 8×8 ins. yellow pine, with 6×8 ins. white pine braces, and in trenches of less depth 6×6 ins. hemlock stringers and braces were used.

The cost of sheeting given above does not include wear and tear on lumber, which is quite an important item. Much less lumber was lost where it was removed by steam than when done by hand. The wear and tear on sheeting driven by the former method was considerably less than where hand mauls were used.

Cost of Trenching.—The work for the month of April, 1896, with 25 working days, gives a fair average of the cost of trenching by machines in sand. These figures do not include repairs, superintendence, nor cost of tools.

Adams Trench Machine.—Trench 33 ft. deep and 12 ft. wide; average number of buckets handled per day, 288, at the following cost:

18 men trenching, at $1.50	$27.00
1 man operating bucket	2.00
1 engineer	2.50
1 water boy	.50
1 foreman	3.00
Coal, oil, etc.	1.00
Total cost	$36.00

Average cost per cubic yard, 12.5 cts.

Moore Hoister and Conveyor.—Trench 35 ft. deep and 12 ft. wide. The average number of buckets holding 1 cu. yd. each handled per day was 286, at the following cost:

18 men trenching, at $1.50	$27.00
2 men operating buckets, at $2.00	4.00
1 engineer	2.50
1 water boy	.50
1 foreman	3.00
Coal, oil, etc.	1.00
Total cost	$38.00

Average cost per cubic yard, 13.3 cts.

Table Showing Contract Prices for Different Parts of Work on West Bluff Sewer System, Peoria, Ill.

Excavating and back filling,	Price per lin. ft. Brick sewers.	Pipe sewers.
under 8 ft. deep	$0.222	$0.205
8 ft. to 10 ft. deep	.266	.272
10 " " 12 " "	.488	.34
12 " " 14 " "	.70	.55
14 " " 16 " "	.92	.76
16 " " 18 " "	1.34	.98
18 " " 20 " "	1.53	1.04
20 " " 24 " "	2.10	2.52
24 " " 30 " "	3.835	
30 " " 36 " "	5.43	
36 " " 42 " "	6.765	
42 " " 48 " "	9.39	

Building Egg-shaped Brick Sewers.

ft.	ins.		ft.	ins.		
1	6	×	2	3,	complete	$0.83
1	8	×	2	6,	"	.88
1	10	×	2	9,	"	.94
2	0	×	3	0,	"	.99
2	2	×	3	3,	"	1.26
2	4	×	3	6,	"	1.49
2	6	×	3	9,	"	1.48
2	8	×	4	0,	"	2.02
2	10	×	4	3,	"	2.14

Building Circular Brick Sewers.

Diam.	lin. ft.	Diam.	lin. ft.	Diam.	lin. ft.
42-in.	$2.06	52-in.	$2.55	68-in.	$4.93
44-in.	2.22	56-in.	2.71	70-in.	5.20
46-in.	2.28	58-in.	2.74	72-in.	5.30
48-in.	2.39	60-in.	2.89	84-in.	6.06
50-in.	2.47	64-in.	3.06	86-in.	6.15
				88-in.	6.38

Furnishing and Laying Pipe Sewers.

Laid complete.	Price per lin. ft.
20-in. pipe and Y's	62.2 cts.
18-in. " " "	45 "
16-in. " " "	44.4 "
14-in. " " "	30.5 "
12-in. " " "	23.3 "
10-in. " " "	20 "
8-in. " " "	12.75 "
4-in. drain tile, with cloth-wrapped joints, laid on 1 × 3-in. boards	3.5 "
¾-in. galvanized wrought-iron pipe, for service pipes to flush tanks, laid and connected, complete	12.2 "
Manholes on pipe sewers, 10 ft. deep, including rim, cover, steps, fixtures, all complete, each	$28.86
Price per foot to be added when depth exceeds 10 ft., and deducted when depth is less than 10 ft., each	2.39
Manholes on brick sewers, 10 ft. deep, including rim, cover, steps, fixtures, all complete, each	22.53
Price per foot to be added when depth exceeds 10 ft., and deducted when depth is less than 10 ft., each	1.94
Flush tanks, exclusive of emptying device, 4½ ft. diam.	30.00
Flush tanks, exclusive of emptying device, 4 ft. diam.	28.86
Flush tank devices, 8-in. siphons	27.40
Flush tank devices, 6-in. siphons	24.42
Price to be deducted from sum of above bids for pipe sewer manhole, 4½ ft. flush tank, and 8-in. siphon, when combination manhole and flush tank is used	1.11
Lampholes 10 ft. deep, with rim and cover, all complete	4.77
Price per foot to be added when depth exceeds 10 ft., and deducted when depth is less than 10 ft.	.11
Storm water inlets and all fixtures, complete, 10-in. discharge pipe	16.10
Price per cubic yard of extra excavation where found necessary in the construction of the work	1.11
Price per cubic yard of extra embankment where found necessary in the construction of the work	2.22
Price per cubic yard for concrete in outfall abutment, and for extra concrete in place	7.77
Price per cubic yard for outfall stone masonry	6.66
Price per cubic yard extra rubble masonry where found necessary in the construction of the work	13.32
Price per 1,000 ft. B. M. timber work in place, other than sheeting, where found necessary in the construction of the work	25.00

For all extra work not included above or in contract and specifications, its actual and reasonable cost as determined by engineer, plus 10% of said cost.

Adams Trench Machine (second one constructed).—Trench 45 ft. deep and 13 ft. wide. The average number of buckets moved per day in sand was 284, at 1 1-9 cu. yds. each, or about 316 cu. yds. per day, at the following cost:

18 men trenching, at $1.50	$27.00
1 man operating bucket	2.00
1 foreman	3.00
1 engineer	2.50
1 water boy	.50
Coal, oil, etc.	1.00
Total cost	$36.00

Cost per cubic yard, 11.4 cts.

Records.—An inspector was placed with each gang of workmen, who were paid for the actual time employed, at the rate of $2.50 per day on pipe sewers, and $5.00 per day on brick sewers, union bricklayers only being employed for brick inspectors. They were required to keep in an ordinary field book a sketch of the line, showing the width of street, position of the sewer in the street, and measurements to each Y or slant for house connection. Each block was measured separately, the zero being in the center of the manhole cover at the lower end, with continuous measurements to the lamphole or manhole at the further end, every measurement being made twice. As rapidly as the lines were completed the inspectors' books were turned in to the office and the notes permanently recorded by platting same to a scale of 40 ft. per inch in leather books of mounted drawing paper, 14×18 ins. in size. The house connections will be platted in these books as rapidly as completed, showing the exact location of same, and with what the connection is made.

Cost.—The cost of the principal items of the work has been as follows:

Construction, amount paid contractors	$332,493.17
Design, including surveys and office work	2,468.94, or 0.74% of cost of work
Inspection	14,133.55, or 4.25% of cost of work
Engineering superintendence	3,530.00, or 1.06% of cost of work

COMPARATIVE COST OF DIFFERENT SYSTEMS OF LIGHTING.

At the last meeting of the Deutschen Verein von Gaz und Wasserfachenannern, Mr. F. Joly, Director of the Electrical Society of Cologne, presented the results of photometric tests to determine the comparative cost of light obtained from different sources and in practical use.

In these experiments the standard of comparison in light was 16 Hefner units; the value of one Hefner unit being somewhere between 1.02 and 1.06 French carcels, and the value of one carcel being 9.5 to 9.6 standard candles. The standard unit of comparison adopted was therefore equivalent to 166.81 standard candles. It was estimated that the electric current sufficient to produce one Hefner unit, by incandescent lamps, was an average of 3.3 watts, at the beginning of lighting, and 3.7 watts after 500 hours of use, the mean being 3.5 watts. The cost of the hundred-watt-hour was placed at 0.0875 francs. The average life of the mantles used in incandescent gaslighting was placed at 400 hours, and the cost of a mantle was taken as 2.50 francs.

The net cost of coal gas was placed at 0.20 francs per cu. meter; that of the litre of alcohol at 0.375 francs for alcohol at 90° C., and 0.325 francs for alcohol at 94° C. The net cost of the litre of petroleum was fixed at 0.1875 francs, and all of these prices apply to Germany alone, the table following being chiefly interesting from a comparative standpoint. For this reason we have left the hourly cost in decimals of francs:

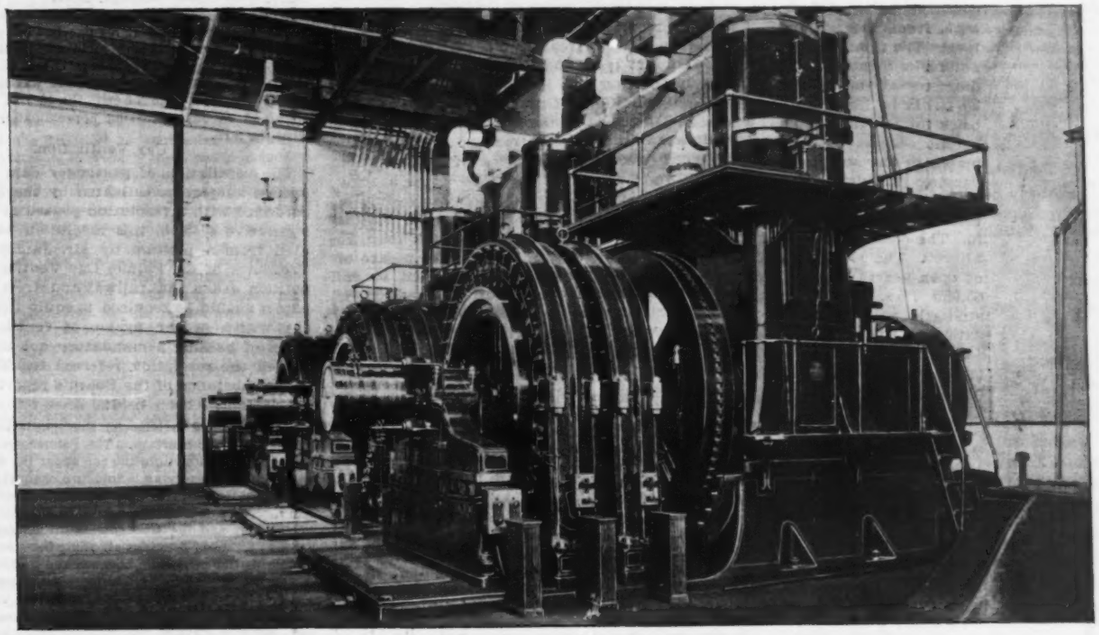
Method of Lighting.	Cost per hour per unit of light, francs.
Incandescent electric	0.0497
Coal gas, cleft burner	0.0220
" " argand burner	0.0266
" " Siemens "precise" burner	0.0200
Incandescent with alcohol:	
Hayduch system, at 94° C.	0.0177
" " at 90° C.	0.0161
Coal gas, Recoverable Siemens burner	0.0157
" " Wenham burner	0.0140
Petroleum, in small lamps	0.0137
" in large lamps	0.0100
Coal gas, with Siemens flat burner	0.0112
" " with incandescent burner, (Welsbach)	0.0087
Electric arc light, with small lamps	0.0082
" " " with large lamps	0.0072

THE DISPOSAL OF WATER FROM STEAM SEPARATORS.

The use of steam separators for removing entrained water from steam before its entry to an engine cylinder has now become so general that the omission of such separators on the piping of any steam plant may be fairly set down as bad engineering. But in the majority of steam plants where separators are in use, very defective methods are in use for the disposal of the collected water. In most cases this water is entirely wasted, and while this may seem a small matter in large plants the water and heat thus wasted represent a considerable loss in the course of the year. For example in a 1,000 HP. plant the consumption of water may amount to 150,000 lbs. per day; and if 2% of this is collected in the separator it amounts to 3,000 lbs. per day. The coal used in heating this from the feed temperature to that at which it is wasted may be 75 to 100 lbs. per day. When these figures are multiplied by the days in a year the annual loss of coal and of water assumes proportions by no means insignificant.

In a condensing plant it is a comparatively simple matter to drain the separators to the hot well, with a suitable steam trap to prevent waste of steam; but in an ordinary power plant the fact that the boilers are usually at a higher level than the separators next the engine, makes the return of the condensed water difficult. An apparatus which has come into quite general use for this work is the steam loop system of Messrs. Westinghouse, Church, Kerr & Co. This ingenious appliance was described in Engineering News upon its first appearance, in our issue of Aug. 2, 1890. It is now so familiar to most engineers that we need only say here that it is merely a system of piping containing no moving parts whatever, by which condensed water is automatically returned to the boiler. In applying the steam loop to a separator, the usual practice is to place the separator in the steam pipe near the throttle, leading the loop from the bottom, and running it to some convenient point where it can be carried up to a height sufficient to drain into the boiler. At or near its highest point condensation in the horizontal portion causes the lifting action by which the flow is maintained against the difference of level and moderate difference of pressure.

It is not necessary, however, to have a steam loop for every separator on a power plant, as by a suitable arrangement of piping a number of separators may all drain to one loop. We show herewith a view from a photograph in the power station of the Brush Electric Light Co. of Baltimore, Md. This station is equipped with three 1,000 HP. Westinghouse engines, and, as shown in the cut, a separator is attached to the horizontal run of pipe leading to each engine. A small pipe drains the bottoms of all the separators and a single loop returns all the water to the boiler with perfect regularity and without attention from the engineer.



VIEW OF WESTINGHOUSE DIRECT-CONNECTED ENGINE IN THE STATION OF THE BRUSH ELECTRIC LIGHT CO., BALTIMORE, MD., SHOWING STEAM SEPARATORS DRAINING TO STEAM LOOP.

THE COST OF BOILER-ROOM LABOR.

Circular No. 6 of the Steam Users' Association, Geo. Atkinson, Secretary, 87 Milk St., Boston, contains some interesting information concerning the cost of labor in steam-boiler plants, which was obtained from a study of statistics furnished by members of the association. The average cost of handling coal is 48 cts. per ton, the minimum 26 cts. and the maximum 85 cts., showing such a wide range that it is evident that a considerable saving may be made in many plants by improving the methods of handling. As to the question of the difference between good and bad firemen, unfortunately, no information is furnished. All that the report has to say on this point is that "the cost of labor in the final comparison should be expressed in cents per 1,000 lbs. of steam, but very few of our members know their evaporation." This statement is undoubtedly true of steam-users in general; only a small percentage of them know whether they are getting a proper equivalent in steam for the amount of coal burned. Although the report is confessedly imperfect, and some of its conclusions are likely to be modified upon further investigation, the labor costs given should be useful to steam-users as a basis of comparison with the costs in their own plants. As the report says: "Our work will be of most value to our members if it leads them to investigate why the costs are more or less in their particular plants than in other plants, under nearly the same conditions. We give below some extracts from the report, which is signed by Prof. Peter Schwamb, in charge, and R. S. Hale, Expert to the Association.

Subject to obvious limitations the conclusions indicated are as follows (only large plants, burning 50 tons a week, are referred to unless stated otherwise):

1. It takes no more hours of labor to fire a ton of hard coal than of soft.

2. Firemen in hard-coal plants receive higher wages by 50 cts. to $1 a week, so that the cost of labor is 5 to 10 cts. per ton greater for hard coal. This is not because hard-coal plants lie in a region of high wages.

3. The men fire more coal (in the proportion of about 15%) and receive more pay (about 10%) in the plants that run 24 hours a day instead of ten hours a day, the result being a cost per ton about 5% less. The difference is not quite so marked when comparing plants burning very large amounts of coal (200 tons a week).

4. The cost gradually decreases as the size of the plant increases, becoming, however, nearly stationary at 200 tons per week.

5. The labor per ton of coal is about 10% less for a steady load than for a variable load of any sort.

6. Men do more work (15% to 20%) and get more pay (10%) according to whether the plant is worked to its capacity or not. The result is a saving of 5 to 10% for the plants that provide a small amount of grate for burning a ton of coal per week, or average a high amount of coal per square foot of grate per hour.

7. The amount of grate a man tends does not seem to affect the amount of work he does. That is, one fireman and a helper do not fire more nor less coal per week than two firemen.

8. Shaking and dumping grates use more expensive men, and each man fires less coal than do cheaper men on ordinary grates.

9. Handling coal should cost about 1.6 cts. per ton per yard up to five yards, then about 0.1 cent per ton per yard for each additional yard.

10. Cheap men do as much work as good men, so that the cost of labor is almost always less per ton of coal with cheap men. The quality of the work may not be the same, so that the cost per ton of steam is not necessarily less.

11. Wages of firemen and work done per man are about the same in the states of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, and Pennsylvania.

12. Small plants.

One man (besides night man) can run engine and fire up to about 10 tons per week.

One man (besides engineer and night man) can fire up to about 35 tons per week.

Two men (besides engineer and night man) can fire up to about 55 tons per week.

Three men (besides engineer and night man) can fire up to about 80 tons per week.

These figures assume that the night man does all he can of the banking, cleaning and starting.

The figures are for average conditions. If the conditions are exceptional, as, for instance, a very long wheel or very variable load, proper allowances should be made.

13. Mechanical stokers save 30 to 40% of labor in very large plants (over 200 tons per week), 20 to 30% in medium-sized plants (50 to 150 tons per week), and save no labor in small plants (less than 50 tons per week).

14. The down-draft grate is more expensive in labor than the ordinary grate (one fair test only).

15. The eight-hour day (in 24-hour plants) is only about

10% less efficient in tons per man than the 12-hour day (one test only).

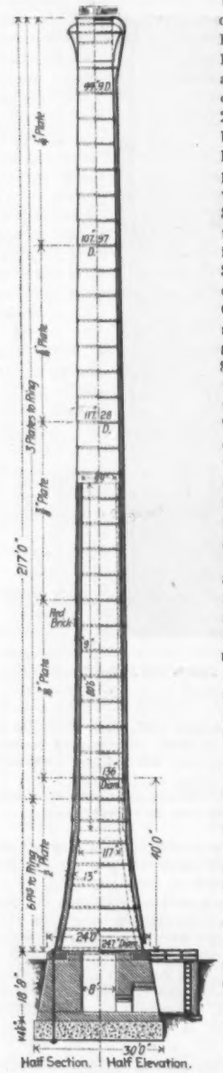
Coal handled per man, cost of labor per ton, etc., in large steam boiler plants:

	Coal.				
	Soft.	Mixed.	Hard.	Soft.	Mixed.
Hours per day	10	10	10	24	24
No. plants averaged ..	21	6	10	8	2
Tons per man per week	21.3	22.8	21.8	26.2	26
Wages of firemen*....	$10.92	$11.48	$12.57	$12.28	$13.13
Cts. per ton (all labor).	52	52	55	47	45

*Per week.

STEEL CHIMNEY AT THE RIDGEWOOD PUMPING STATION, BROOKLYN, N. Y.

We illustrate herewith a steel chimney recently built for the Ridgewood Pumping Station of the Brooklyn Water-Works, by the Philadelphia Engineering Works, Limited. It is one of the tallest steel chimneys in this country, being 217 ft. high from the ground level. The minimum diameter is 8 ft., and the diameter at the base is 25 ft. It is lined with brick for one-half of its height. There are 137 plates in the structure, varying in weight from 800 to 1,400 lbs., and in thickness from ¼ to ½-in. The cost was about $10,000. The plates are of open-hearth steel, of 65,000 lbs. tensile strength, with an elongation of 20% to 25% in 8 ins. An iron ladder extends from the bottom to the top of the shell. The chimney was erected in ten weeks. The work of erecting was done from an inside scaffolding which was raised as the work progressed.



Steel Plate Chimney at the Ridgewood Pumping Station, Brooklyn, N. Y.

Built by the Philadelphia Engineering Works, Ltd.

The advantages of such a chimney over the ordinary brick structure lie in its smaller first cost, in its lesser weight, permitting a secure foundation to be made in unstable soils and in the rapidity with which it can be erected.

On the other hand there are many progressive engineers who regard all such great chimney shafts of either brick or steel as uneconomical and out of date. A chimney is after all a heat engine which does a certain number of foot-pounds of work in moving air and products of combustion, and when one computes these foot-pounds he realizes what a large sum he is expending on a motor which develops a mere trifle of power. The number of power plants is all the time increasing in which the chimney is made only tall enough to discharge the products of combustion where they will cause no nuisance, and a power-driven fan or blower forces the air for combustion through the fuel and the boiler flues.

The sole advantages of the chimney are its extreme simplicity and the fact that it does its work with practically no attendance. These will doubtless keep it in use for all power plants of small size; but for plants of large size the tendency is steadily increasing toward the use of mechanical draft.

REPORT OF THE MASSACHUSETTS STATE BOARD OF RAILROAD COMMISSIONERS.

The report for the year 1896 shows that there has been no increase in mileage during the year and that of 49 railway corporations only 13 are engaged in actual operation, 34 companies' lines being leased to or operated by other companies. Five of these 13 operating companies had over 96% of the mileage and conducted nearly 99% of the entire passenger and freight traffic. In financial affairs there was an increase of 2.01% in gross earnings, 4.05% in operating expenses and 1.79% in net earnings.

Transportation of Bicycles.

The transportation of bicycles is one of the interesting matters treated of in the report. The General Court in January, 1896, passed a resolution instructing the Board to investigate the terms and conditions of carrying bicycles on railways, and to report to the Court what legislation would be advisable in the matter. Public hearings were held and both sides of the question were fully presented. At the close of the hearing the parties interested agreed upon a schedule of reduced rates which has been approved by the Board. With a passenger fare of less than 75 cts., the bicycle charge is 10 cts.; with a fare of 75 cts. to $1, the charge is 15 cts., and so on, these rates being a reduction of 33⅓ to 50% for the shorter distances and 25% for longer distances. In view of this agreement on the part of the railways, the Board considered that no legislation was necessary with regard to the carriage of bicycles. The following extracts from the report give some of the arguments on both sides of the question:

So long as the railway company for a passenger fare carries with the passenger a trunk up to 150 lbs. in weight, it should carry a bicycle instead of a trunk, if the passenger so elects. The company should not be asked to carry without extra charge a bicycle for a passenger who has a trunk or any other baggage; nor should the company be expected to carry a passenger with bicycle on a low-rate coupon or mileage ticket, but only on a full-fare single ticket. The bicycle should not be required to be covered or protected, and should be carried at the risk of the company and not of the owner.

It was urged that the free carriage of bicycles would attract travel to the roads, and would be a source of profit rather than of loss. The need of suitable provision for their carriage, whether with or without charge, was also emphasized. Reference was made to the statutes of New York, Ohio and Rhode Island, by which bicycles are declared to be "baggage," and are required to be transported, not exceeding one for each passenger, subject to the same charges and liabilities as for baggage, and without being crated, covered or otherwise protected. It was stated that about 150 transportation companies, large and small, most of them small, had adopted the practice of free carriage, though it appeared that some of them had abandoned it after trial.

Among the counter-points and suggestions were the following: A railway company cannot be required to perform any transportation or service without a reasonable compensation. The validity of statutes providing for the free carriage of bicycles is not conceded by the railroads of the States where such statutes have been enacted. It is the custom to carry without additional charge certain articles of wearing apparel and personal effects for the use and comfort of a traveller, known as "baggage;" but the bicycle does not come within the proper and recognized meaning of this term.

Personal baggage is required to be packed in trunks or otherwise protected so that it may be handled with the expedition demanded in passenger traffic and may be secure from loss or damage while in transit. The bicycle, on the other hand, which from its structure is peculiarly liable to expensive injury, is to be received and transported without cover or protection of any sort, but with the same risk and liability on the part of the carrier as for protected baggage. It consists, moreover, of numerous nicely adjusted parts and attachments. The employees of the baggage department have not the time, and usually have not the skill, minutely to inspect each bicycle offered so as to determine whether it is in good order and condition when received. The company is consequently exposed to frequent claims for injury or for loss of special parts, which it cannot verify or, if fraudulent, disprove, and which are a source of serious and costly annoyance.

A bicycle takes up much more room than a trunk of ordinary size and allowable weight. Bicycles require not only extra space in baggage rooms and cars, but extra service of employees. Bicycles must be received, checked and delivered at the baggage room or other room provided for the purpose. Provision must also be made for their storage while waiting shipment or delivery. A man who can carry on a truck twenty trunks at a time, can handle but two bicycles, so that twenty bicycles require ten trips between the baggage room and car.

It was further stated that the number of bicycles offered for transportation is so variable and uncertain that they cannot be provided for with system and economy. A bicycle meet or excursion, or an unexpected change of weather, may precipitate upon the railway scores or hundreds of wheels, often at way stations, for which it is unprepared and for which its regular facilities are wholly inadequate.

The effect of free carriage in New York appears to have been an increase by some 60 or 70% in the number of bicycles carried on local and suburban trains, without corresponding increase in number of passengers. The result must necessarily be an increased cost of service and a tendency to higher passenger fares.

At the time of the hearing, bicycles were carried on the railroads of this State at regular "excess baggage" rates, so called, a bicycle being rated at 100 lbs. The lowest charge for a bicycle under this tariff was 15 cts., this being the charge when the passenger fare was less than 40 cts. If the fare was 40 to 74 cts., the bicycle charge was 20 cts.; and so on, increasing approximately in that ratio with the fare.

Car Ventilation.

The ventilation of passenger cars was another special subject investigated by the Board, in accordance with a resolution passed at the previous legislative session, this resolution having originated from a petition by Mr. James M. Palmer, Treasurer of the Palmer Car Ventilating Co. The petition asked that railway and street railway companies should be required to equip their passenger cars with a proper system of ventilation, but instead of passing a mandatory act the legislature passed the resolution referred to. The following is the substance of the Board's report after public hearings had been held:

Three patented systems for the ventilation of cars were presented at the hearings. The Palmer system consists in taking the fresh air into the car under the hood at the forward end, and carrying it into two channels which extend the entire length of the car, one on each side of the clear-story. There is a partition in each channel at the middle of the car, and the fresh air is discharged into the car through screened openings all along between the front and middle of the car, while between the middle and the rear end of the car the foul air is intended to pass out through similar openings into the channels, and thence into the open air. This system was invented some twelve years ago; but it is claimed that improvements have been made from time to time, the latest within a few months. The system has, however, never been introduced except tentatively on any railroad. Two cars equipped with it have been running on the Boston & Maine R. R. for several years, and one on a western road for about a month. It was tried on one or two street railway cars, but only for a short time.

The second system presented was that which bears the name of its inventor, Mr. William G. Creamer. By this system the fresh air is taken in through a funnel-shaped opening at each side of the car near the front, and is passed down and along the heating pipes in wooden boxes, from which it enters the car near the floor at various points. The foul air is designed to be exhausted by automatic ventilators at the clear story. This system was patented originally in 1861, but later improvements are claimed to have been made. It has been applied experimentally to cars on various railways, but never to any considerable extent, and it cannot be said as yet to have approved itself as a success in practical railroad use. Its most extensive use is on the cable railway on the New York and Brooklyn bridge, where 44 cars equipped with it are now running, 20 of them having been equipped the last year.

The third system, also named from its inventor, was presented by Mr. George H. Maynard, who has a patent only about a year old. By this system the foul air is withdrawn from the bottom of the car through a register on each side, by means of automatic exhaust ventilators at the top of the car. The fresh air enters at the ends of the car through transom windows. The system is now in experimental use on several cars of the Fitchburg R. R.

The questions to be considered appear to be these:

1. Are the methods of ventilating passenger cars now in general use reasonably satisfactory?

2. If not, are there any methods which have been shown by experience or otherwise proved to be on the whole more satisfactory?

3. Is it at present desirable that there should be any specific legislation on the subject?

In considering the first question, a distinction is to be taken between the conditions which exist in summer and those which exist in winter. In winter, the car must be warmed as well as ventilated. In summer, the ventilation

is by means of open doors and windows,and cannot be said to be insufficient. It might be possible to devise a system theoretically more perfect, that is, insuring a better regulated supply of pure air to each passenger, without drafts are without dust or cinders; but such a system, in order to be effective,would require (as will be seen) that the doors and windows be kept closed; and if it were desirable, it is not practically possible to keep the windows closed in summer, since passengers will not submit to it. The question of car ventilation as a practical question is therefore limited to the methods which can be used during the season when the windows must as a rule be kept shut in order to maintain a proper degree of warmth inside the car.

The usual methods of ventilating passenger cars consist in taking the fresh air in through openings at the end of the car, either over the door or between the door and the sides, and also through movable sashes in the top of the car at the sides of the clear story. The foul air escapes through similar openings, and probably in some cases fresh air comes in and foul air goes out through the same opening. This system cannot be said to be a theoretically perfect one, nor in its practical working all that could be desired. Tests have shown that the air in the car is at times more impure than is desirable or conducive to health. This is especially true in sleeping cars.

The evil does not appear, however, to be by any means so serious as it is sometimes depicted by theorists, valetudinarians, and the inventors of ventilating apparatus; and the present methods, if properly used, would undoubtedly give much better results than they do. The trouble frequently appears to be that the means provided are not intelligently and systematically used by trainmen, or that their use is not permitted by passengers. Many persons object, often unreasonably, to the opening of a ventilator anywhere near them, and it is not an uncommon thing to find a car with all of the clear-story ventilators closed. Such was the case in three out of the eight sleeping cars of which the air was tested and the results given in the report of a committee of the Master Car Builders' Association in 1894. A paragraph in the report touches on one of the difficulties just referred to, and proposes a remedy.

Great improvement could, however, be made in the condition of the air in our crowded passenger cars, if the trainmen were compelled to pay proper attention to the ventilators. A regular set of instructions should be furnished them for their guidance, and division officers should be instructed to pass through the train at every opportunity, and to report cases where the ventilators have been neglected, and the air is overheated or foul, to the division superintendent for discipline. The men would then soon learn to attend to this part of their duty. Sleeping car companies should have a code of rules printed and posted in the cars, and their porters and conductors should be made to observe such rules.

Admitting that the methods now in general use are not all that could be desired, and that in fact they fall far short of an ideal system, the question arises whether there is any other available system which is radically better, or on the whole more satisfactory. The answer must be that no such system, so far as the Board has been able to learn, has as yet been discovered and has borne the test of practical success,—though it is probable that a more perfect system may yet be devised.

The problem of car ventilation involves conditions which are peculiarly variable and complex. A car is sometimes in motion and sometimes at rest; sometimes it runs slowly, sometimes rapidly; sometimes it moves with the wind, sometimes against the wind, and sometimes at right angles to the wind; its doors and windows are sometimes open and sometimes shut. The passengers in a car, moreover, differ widely in temperament, health and habits of life, in sensitiveness to heat and cold and to drafts of air. Some are young and robust, others are aged or feeble. Some desire a high temperature, some prefer a low temperature; some want to sit by an open window, others cannot endure a current of air without taking cold; some are warmly clad, or retain in the car their overcoats and furs; others are thinly clad, or remove their outer garments as they would in a sitting-room. At stations, the doors of a car are necessarily thrown open, sometimes for several minutes; and they are also opened from time to time while the car is in motion, for the passage of the conductor and brakemen through the train.

All these varying conditions make the systematic ventilation of a railroad car much more difficult than that of a building or room. The opening of the doors and windows is a troublesome disturbing factor. If these could be kept closed, it would be much easier to devise an efficient system of ventilation. It has been found impracticable, however, to construct cars with windows that cannot be opened, even in the winter. Instances have repeatedly occurred where passengers have forcibly broken out the windows when it was found that they could not be raised. Even in the coldest months, there are days when the steam heat renders it as desirable to open the windows as it is in summer. No system of car ventilation appears as yet to have been discovered and successfully tested, which is thoroughly efficient except when the car is in motion and the doors and windows are closed; and this is as true of the systems which have now been urged upon the attention of the Board, as it is of other systems.

The difficulties, then, in the way of securing perfect ventilation are partly physical and partly due to the idiosyncracies of passengers; and of the two, the latter are the harder to deal with.

An ideal system would provide for admitting a proper supply of pure air, without draft, cinders or dust, and for carrying off an equal quantity of vitiated air. The fresh air should be warmed in winter, and should be made to circulate through the car before leaving it. The ventilation should be independent of the motion of the car, acting when the car is standing still as well as when it is in motion; and there should be a slight excess of pressure inside the car, so that the tendency would be to exclude smoke and dust.

The existing methods are far from fulfilling these conditions; and the Board knows of no system, which has been practically tested, that is not open to some serious objection. If the fresh air is admitted at the top of the car, it should be warmed by some special heating apparatus, and the foul air should be removed from the bottom of the car at the other end, which necessitates separate inlets and outlets at each end of the car. If the fresh air is admitted at the bottom of the car, after being carried along steam pipes, it is not only very unequally heated, depending upon the distance it has travelled along the pipes, but in entering it stirs up the dust and deposits on the bottom of the car, which, as the scientific experts in sanitation have taught us, may be charged with the germs of tuberculous and other disease, and should by no means be disturbed.

It is not improbable that the best system of car ventilation will prove to be one which is not dependent for its action upon the motion of the car, but in which the supply and change of air are effected by means of fans operated by power. No such system, however, has as yet been sufficiently tested to prove its success. Experiments in the use of fans were made some years ago on the Central Railroad of Georgia, but after a short trial the method was abandoned. This is the only instance which has come to the notice of the Board in which fans have been actually used.

We are satisfied by the evidence adduced at the hearings, as well as by information obtained from other sources, that the railway corporations of the country have not been indifferent to the importance of car ventilation as effecting the health and comfort of their passengers. They have made it for many years the subject of study and experiment. The question of cost does not appear to have controlled their action, and the difference of cost is not indeed a factor of much account, at least in the construction of new cars, as between the practicable systems open to selection. The companies have from time to time allowed one or more of their cars to be fitted up, under the immediate direction of the inventor, with any system the system to promise better ventilation, and have given the system a fair trial on their roads. Each of the systems presented at the hearings has had or is having this opportunity. If any system, after years of persistent advocacy, has failed of general adoption, it must be because the supposed merits of the system have failed to impress themselves upon practical railroad men, upon scientific experts and upon the general public. While there was testimony at the hearings tending to show that in some of the cases referred to, there was, under favorable conditions and for the time being, a somewhat better result obtained, the weight of the evidence was not sufficient to prove that as a general result, under ordinary and similar conditions, there was any marked or easily perceptible difference in favor of the cars ventilated by even the best of the patented systems, or that these cars were sought by passengers in preference to cars ventilated in the usual way.

The subject of car ventilation, while apparently little progress has been made, has not escaped the attention of engineering organizations or of scientists. In 1893, the Master Car Builders' Association appointed a committee on the subject, which submitted a report at the annual meeting in 1894. That report, however, made no specific recommendations, and did little except to formulate the ideal conditions, and to give the results of some tests of the air in cars and of the efficiency of some different types of exhaust ventilators.

The American Public Health Association has also taken up the question through a committee on Car Sanitation, which has submitted several reports, chiefly calling attention to the need of better ventilation and cleanliness in cars. In the report presented at the meeting at Denver in 1895, there is a paper by Prof. S. H. Woodbridge* in which a fan system of ventilation is proposed. The paper concludes as follows:

> It would seem to be of more than doubtful utility to equip coaches with carefully designed means for ventilation, unless railway employees are systematically trained to their use and they and the traveling public are educated to habits of cleanliness,and are free from the trouble-making notions and imaginings which prevail, even among cultivated people, with reference to ventilation. The proper function of ventilation begins only after cleanliness has done its most perfect work.
>
> Any successful coach ventilation must include such self-announcing means as shall enlist imagination in its favor, and put an effective stop to window raising, that fatal disturber of the working of artificial ventilation. The railway management must also be called upon to provide whatever may be required to remove every reasonable excuse for window opening.

*Professor of Heating and Ventilation in the Massachusetts Institute of Technology.

It has not been made apparent to the Board, by the testimony at the hearings or otherwise, that there is grievous complaint by the travelling public about the ventilation of passenger cars, on either railways or street railways; or that there is any general demand for radical reform or relief through mandatory legislation. Much more frequent complaints come to our ears of the overheating or underheating of cars, than of their foul or vitiated atmosphere. It is perhaps safe to say that the complaints of bad or insufficient car ventilation are not more numerous or well-grounded than those which are heard with respect to many public buildings and places of assembly for whose ventilation experts of high repute have been employed and no expense has been spared; and the problem is less difficult and complex in the latter than in the former case. This, however, is no reason why there should not be persistent study and effort for the more perfect ventilation of passenger cars.

It is evident from all that has been said, that car ventilation is still in its experimental stage; and that no artificial system or method has as yet been so fully perfected and so thoroughly approved by successful use, as to warrant the Board in recommending its general adoption under the constraint or regulation of law. The Board accordingly reports, as the result of its investigation, that no specific legislation on this subject appears to be at present expedient.

Grade Crossings.

There are now 32 railway grade crossings in the state, 22 of which are equipped with interlocking plant, and 10 are "know-nothing" crossings where all trains are required to stop. On June 30, 1896, there were 2,155 grade crossings of highways and railways, 70 such crossings having been eliminated during the past five years. Of the 2,155 crossings, 1,154 are protected by gates, flagmen or electric signals, and 1,001 are unprotected. The number is steadily being reduced, and the most extensive work of this character is on the New York, New Haven & Hartford R. R. near Boston (Eng. News, Jan. 14, 1896) and on the Boston & Albany R. R. at Newton (which we shall describe later). The total cost of abolishing grade crossings to date under the provisions of the act of 1890, has been $6,147,923, of which the state has paid $1,313,000, the cities and towns $423,104, and the railways have paid the balance.

A LIBERAL ENGINEERING SALARY, of $17,500 per year, has been fixed by the Liverpool Dock Board as a compensation for its new Engineer-in-Chief, Mr. A. G. Lyster. Mr. Lyster had been assistant engineer to and succeeds his father, Mr. George Fosberry Lyster, who has been dock engineer since 1861, and who is now retired with an allowance of $12,500 per year granted by the Board. The elder Mr. Lyster carried out works, at Liverpool and Birkenhead, which are estimated to have cost $70,000,000. The action of the Liverpool Dock Board, in so handsomely appreciating the long services of a faithful and efficient engineer, is in somewhat striking contrast to the usual corporate method of replacing officers worn out in their service.

NORTH SEA AND BALTIC CANAL TRAFFIC, for the first working year, ending June 30, 1896, is disappointing, owing chiefly to high charges. Only one-fourtth of the estimated tonnage, or 16,834 vessels with an aggregate carrying capacity of 1,505,983 registered tons, used the canal in the year. Of this number of vessels, 7,531 were steamers with 1,140,588 tons capacity. The tolls collected for the year amounted to 896,456 marks, or $224,114. Dr. L. Boyseu, Secretary of the Kiel Chamber of Commerce, said that the charges were so high as to deter shipmasters from using the canal. Further than this, captains are prone to take the route they are accustomed to and continue to make the voyage around the Skaw. The new tariff, which went into effect on Sept. 30, 1896, is a considerable improvement on the old one and the raising of the permissible speed from 6 to 7½ miles per hour is a welcome concession.

GERMAN EXPORT CONDITIONS IN EASTERN ASIA are to be intelligently studied by a commission of experts sent out by the Ministry of the Interior, and charged with the duty of opening up further opportunities for German commerce, and of studying prospective Japanese competition. Meanwhile the Germans are certainly holding their own in competing for foreign business. A German firm has secured the contract for the Simplon tunnel; Siemens & Halske have obtained, against British bids, the contract for lighting the City of Mexico, and the same company is to develop the electric lighting system of Moscow. In Germany itself there is great activity in electrical development, and the latest project is for an electric road from Leipsic to Dresden.

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In reviewing the report of the Commission of Engineers upon the Nicaragua Canal enterprise in our issue of March 26, 1896, we pointed out that the only course for Congress to pursue, unless the enterprise was to be permanently shelved, was to provide at once for the full surveys and investigations which that Commission recommended. The Congressional committees in charge of this bill could easily have secured an appropriation for such surveys at that time; and had they done so the work would be now well advanced toward completion.

But instead of taking this course the alleged friends of the enterprise and those who did their bidding on the Congressional committees in charge of this matter determined on a course which is probably unparalleled for its political stupidity. They decided to advocate the passage of the bill as originally introduced, with its government guarantee of $100,000,000 of bonds and subscription to $70,000,000 of stock, unaltered, thus entirely ignoring the report of the Engineering Commission appointed in accordance with the express act of Congress. Apparently the Washington agents of the Nicaragua scheme believed that the enterprise was so popular with the general public and with the members of Congress that it could be pushed through on these lines, regardless of the facts set forth in the report of Messrs. Ludlow, Noble and Endicott.

It is true that the Nicaragua Canal is an exceedingly popular enterprise. A year ago there was hardly a journal in the country that did not favor it. The report of the Engineer Commission did not condemn it as an enterprise by any means. It simply advised that before the United States put $100,000,000 into the scheme, it should take just the same steps to prove the investment a wise one that any banking firm or private individual would take. A year ago, we believe, an appropriation for further surveys of the canal route could have been carried without a dissenting vote.

But those in charge of the fortunes of the Nicaragua Canal bill were playing for higher stakes, and they determined upon the bold move of pushing through the bill as it stood. They not only ignored the report of the Engineering Commission, but they kept it from publicity so far as possible. The edition printed was made so small that the report was inaccessible to the general public, and the valuable maps and plans which accompanied it were not printed at all. To this day the only publication of this report accessible to the general public is that which was made in the columns of Engineering News, in our issue of March 26, 1896.

We say that the committee determined to push through the canal bill in its original form; but they did not undertake to do it at once while the fact that a commission of engineers had reported upon it was fresh on the public mind. Perhaps the delay of nearly a year was merely the usual delay attendant upon Congressional action. On the other hand, it may be that it was thought wiser to wait until the public had forgotten the engineer's report, and it could be lightly dismissed, as a thing of no consequence. Whether this be so or not, we have no means of knowing; we can only say that the public hearings on the House bill, which lie before us, closed on May 9, 1896. With the known large friendship for the enterprise in Congress, it ought to have been possible for those in charge of the bill to have forced action on it at the last session of Congress, had they so desired.

Be that as it may, however, the Senate, as all our readers know, has recently taken up the bill, and at the outset the indications were strong that it would be passed in its present form. Newspapers of a certain class immediately echoed the words of Senator Morgan and his allies, and it seemed as if the report of the Engineering Commission and the warnings of the engineering press had had no effect whatever upon the public mind.

But those who thought this was the case have had a remarkable object lesson during the past week or two; a large number of influential newspapers have joined the protest against the folly which is proposed, and every day lessens the prospect that it can be carried out. As many of our readers may not be aware of the strength of this opposition, we have decided to print extracts from recent editorials in a number of prominent journals, and have done so below.

We believe this whole incident is worth the attention of our readers as an illustration of the influence of a report by an able and impartial commission of engineers upon public opinion. The politicians may squirm and manoeuver as they please, but they find such a document a very hard thing to get around or ignore.

As for the Nicaragua Canal scheme itself, this journal is, as it has always been, one of its strongest supporters; but it firmly believes that those who have posed as the friends of the scheme in trying to force a government guarantee through Congress at the present time, have actually done enormous harm to the project by arraying against it many influential journals who have hitherto been its supporters. It may not be an easy matter to win them back.

Those who have charge of the enterprise ought by this time to have learned some wisdom as to the extent to which they can disregard public opinion and the public interests. It is not yet too late for them to retrace their steps and provide for the full surveys and investigations which the Engineering Commission recommended. But if they continue their present course and turn a deaf ear to this recommendation they will give good ground for charges that a complete examination of the enterprise is what its present promoters of all things wish to avoid.

In reprinting the newspaper editorial opinions below, we should not be understood as approving their position in all respects. We present them merely as an illustration of the growing enmity to the Nicaragua enterprise which the actions of Congress concerning it are fostering.

From the New York "Journal of Commerce."

The Association of American Manufacturers has taken strong ground in favor of the Nicaragua Canal, due, it seems to us, to an insufficient consideration of the grounds on which that enterprise is opposed. Its friends have understated its cost and greatly overstated its possible usefulness. As the proposed tolls on a steamer of 3,000 tons would cover the operating expenses of the steamer for thirty days, there are few lines of steamers that could afford to use it, especially as such articles as the lumber of our own Puget Sound and the nitrates of Chili constitute a great part of the Pacific commerce, and the route through the Nicaragua Canal would be actually longer than the Suez route, between some of the most important ports of the Oriental and the Occidental world. Add to these the enormous engineering difficulties of constructing the canal, the experience of our government in assisting like enterprises, and the fact that the canal would be in a foreign country, and for reasons obvious to all military and naval officers, would revolutionize our foreign policy and greatly increase our army and navy, and it seems to us that the reasons why our government should not undertake this work are very strong.

From the Detroit "News."

Right upon the heels of the Pacific railway legislation comes the Nicaragua Canal project, which is an affair of vast interest to the United States. The lesson of the Pacific railway affair should teach the government to avoid any partnership business with a stock company. We have not only our own experience to profit by, but the history of the Panama canal frauds, which have not yet been forgotten.

In spite of these facts, the first move in the present project is an attempt to fasten the government to another alliance with a stock company, and the methods displayed have a decided Pacific railway flavor. Senator Morgan is playing the distinguished role once filled by Oakes Ames in pushing this kind of a grab game in Congress, but it does not yet appear if there is another Credit Mobilier scheme behind him, which will attempt to buy votes with gifts of stock.

As an evidence that the company is not acting in good faith, it may be said that the government has, at great expense, had a survey and special investigation of the proposed route. The commission reported, after viewing the difficulties to be overcome, that it would cost at least $135,000,000 to cut the canal across Central America, and grave doubts were expressed if the work could be done for that amount. If the canal can be constructed for $200,000,000 it will probably be a paying investment, but if the government is to take a hand in its construction it should do it as a purely national enterprise. There has been enough of the practice in which the government furnishes the money and gets laughed at for its stupidity in granting away its rights to an unscrupulous corporation.

From the Detroit "Free Press."

A year ago last month the government engineers appointed to examine into the practicability and cost of a ship canal across the Nicaragua isthmus, reported that the success of the enterprise was problematic and that the company's engineers were $50,000,000 too low on their most liberal estimate. Has the senate forgotten this report, that it now should propose to finance this great undertaking without further inquiry?

It is no doubt of tremendous commercial importance to this country that the Nicaragua ship canal become an accomplished fact; but surely the government has had sufficient experience with transportation schemes aided with public funds, and a plenitude of recent revelations concerning the funding of railroads not to vote away $170,000,000 until there is the fullest guarantee of the feasibility and exact cost of the project.

From the Grand Rapids, Mich. "Democrat."

The government commission of engineers appointed to investigate the feasibility of the route, cost, etc., etc., about a year ago, reported that the company's estimate of cost was $50,000,000 too low, that unless the plans were materially changed, failure would be the probable result, and recommended further and more thorough investigation before action. There has, however, been no further investigation. Senator Turpie's fear, expressed in the Senate yesterday, that the Nicaragua canal scheme, if entered upon by the government under the terms of the bill now before Congress, will prove another Pacific railway swindle upon the people, will be pretty generally believed by the public to be only too well founded. And there is undoubtedly a growing tendency, also, on the part of the American people to agree with the Indiana Senator that, if the United States are to take any hand in the business, they should assume full control and build and own the great waterway exclusively.

From the Minneapolis "Journal."

There is no doubt that enormous benefits would accrue to the Pacific coast by the opening of such an interoceanic ship canal and, not only to that section, but to our country generally, in convenience and speedier water communication between the Atlantic and Pacific. But no process of a government guarantee of canal bonds should be considered. The country has had enough trouble with the government guarantee of the Pacific railroad bonds.

From the Chicago "Times-Herald."

About two years ago the government appointed a board of engineers to examine into the practicability of a ship canal across the Nicaraguan isthmus and the cost of building it. Their report was made a year ago last December, and they say that the feasibility of the scheme is doubtful and that the cost would exceed by $50,000,000 the largest estimate made by the company's engineers.

Since this report no further investigation has been made, but the senate is going right ahead to pass the bill the same as if the report of the government engineers had been entirely favorable. Senator Morgan knows a great deal more about this canal and its practicability than any board of engineers that ever set a squadron of chainmen in the field or solved the easiest problem in trigonometry. He knows it all, and is determined to lead his countrymen into this Nicaraguan ditch.

Upon the ultimate merit of the canal project the Times-Herald expresses no opinion at this time, but it insists that there should be a further examination and investigation by the government engineers of the ultimate cost of the canal and its practicability before a single dollar is pledged to it by congress.

From the St. Paul "Globe."

There is no more wicked, infamous or corrupt scheme before the public to-day in any country on the globe than this Nicaragua canal job. Admitting the value of an interoceanic canal, there are two perfectly plain choices and only two, which this people should consider. If the undertaking is sufficiently important to us as a government, let the government build the canal, operate it and pay the whole cost of it. If it is not, then let the government have nothing to do with it, and private capital and private enterprise, if the scheme is what its members set forth, will take care of the project without assistance from the treasury. The persistence of fraud and the undying purpose of corrupt politicians to swindle the people form the only explanations of an act to guarantee the bonds of the private company, after what has happened in the case of the Pacific railroads, and with an

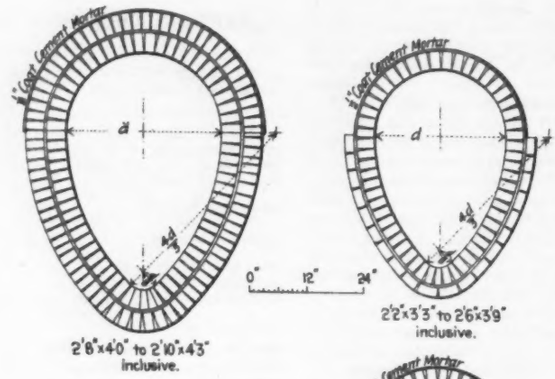


FIG. 1.
CROSS SECTIONS
OF EGG-SHAPED
BRICK SEWERS.

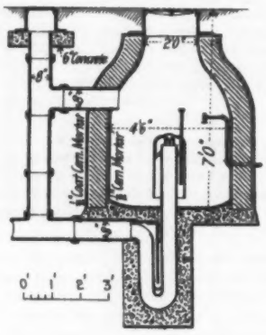


FIG. 2.
STANDARD FLUSH TANKS.

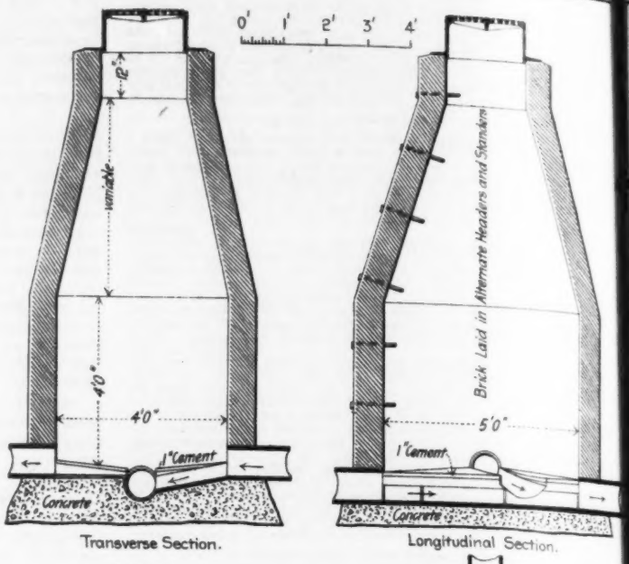


FIG. 5.
MANHOLE CONSTRUCTION
FOR
PIPE SEWERS.

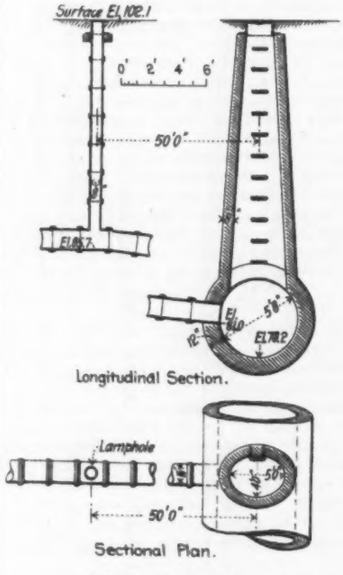


FIG. 9. CONNECTION
BETWEEN LATERAL AND MAIN SEWERS
WITH DIFFERENT FLOW LINES.

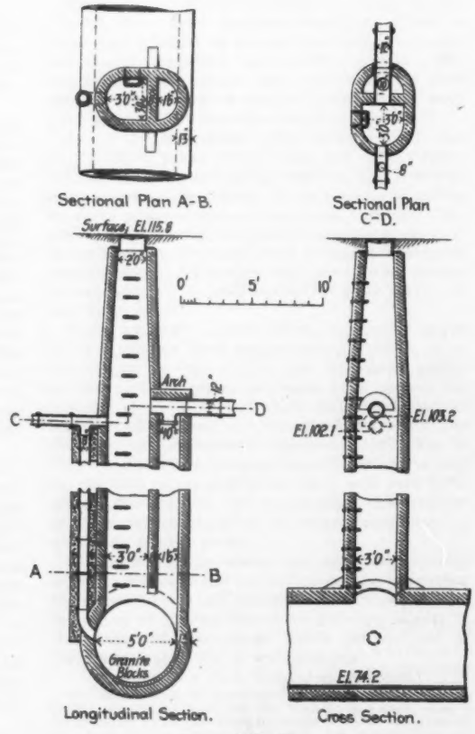


FIG. 7.
DROP INLET FOR 8-IN. AND 10-IN. PIPE SEWERS.

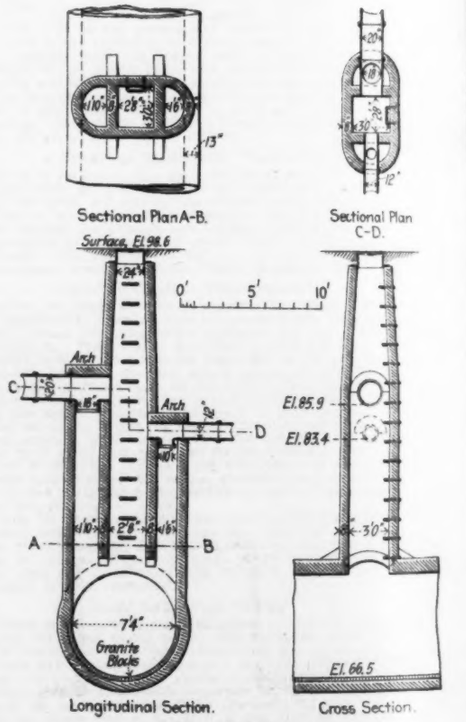
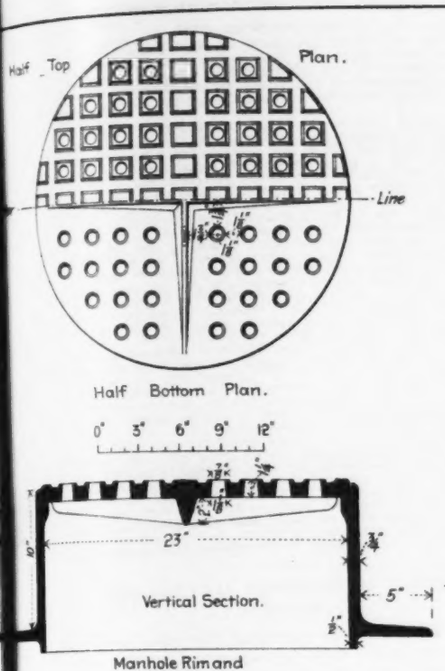


FIG. 8.
DROP INLET FOR PIPE SEWERS OVER 10 INS. DIAM.

WEST BLUFF SEWER SYST

C. G. Elliott, M. Am. Soc. C. E., Engineer in Charge of Construction. T. B. Townsend Brick



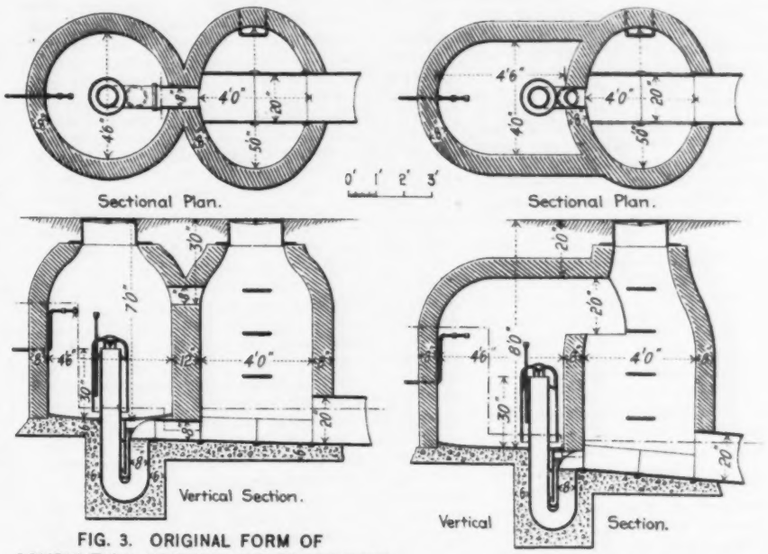


FIG. 3. ORIGINAL FORM OF COMBINATION MANHOLE AND FLUSH TANK.

FIG. 4. IMPROVED FORM OF COMBINATION MANHOLE AND FLUSH TANK.

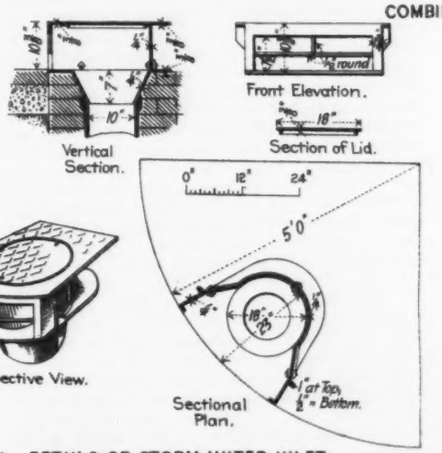


FIG. 11. DETAILS OF STORM WATER INLET.

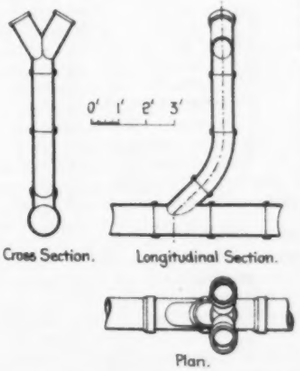


FIG. 12. HOUSE CONNECTION STAND PIPE CONSTRUCTION.

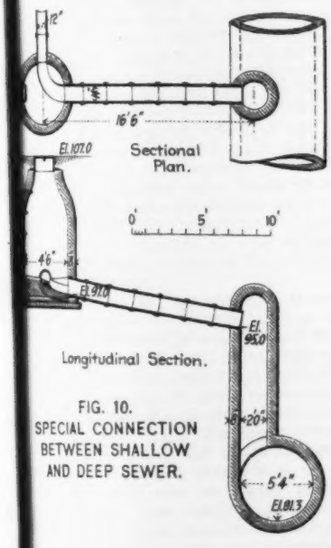


FIG. 10. SPECIAL CONNECTION BETWEEN SHALLOW AND DEEP SEWER.

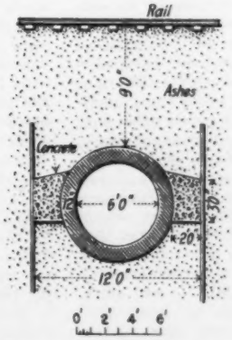


FIG. 13. REINFORCEMENT OF BRICK SEWER PASSING UNDER RAILWAY TRACKS.

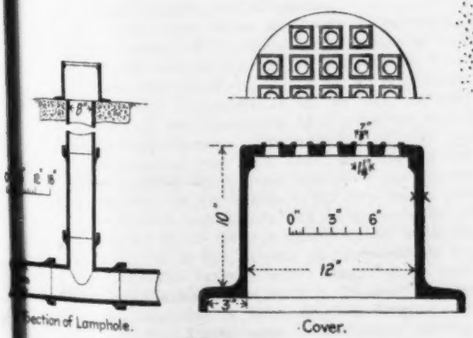


FIG. 6. DETAILS OF LAMP HOLE CONSTRUCTION.

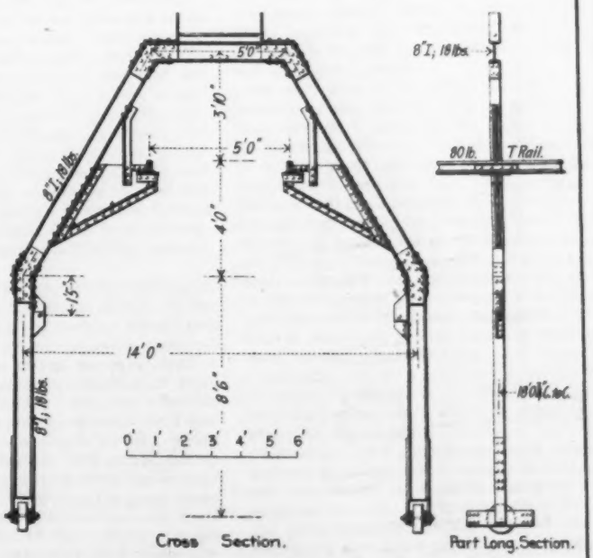


FIG. 17. DETAILS OF ADAMS SEWER TRENCHING MACHINE.

EWER SYSTEM, PEORIA, ILL.

send Brick & Contracting Co., Zanesville, O., Contractors. A. W. Gates, Engineer for Contractors.

CHAS. HART & SONS, LITH., 88 VESEY ST., N. Y.

empty treasury and a deficient revenue appealing to us for help.

From the Omaha "Bee."

In his speech on the Nicaragua canal bill, Senator Morgan expressed the opinion that there would be a large financial profit from the canal, even if the commerce of that waterway was but half that of the Suez canal, on a basis of $1.50 per ton against the Suez canal rate of $1.87 per ton.

It must be presumed that these senators have carefully considered the question of the probable income of the proposed canal and also that of the cost of its operation, but nevertheless their judgment as to the financial results of the enterprise cannot be accepted as conclusive. There is expert opinion in regard to this which does not support the view of the senators above referred to.

Mr. Joseph Nimmo, formerly chief of the bureau of statistics of the Treasury department and a well known publicist, has presented arguments and facts tending to show that the Nicaragua canal, if built, could not possibly pay. Estimates of the tonnage likely to use an isthmian canal are, in Mr. Nimmo's opinion, absurdly exaggerated by the advocates of such a canal. Instead of an annual tonnage of 6,000,000 or 8,000,000 tons, Mr. Nimmo thinks 500,000 tons is a large estimate of the tonnage likely to use any canal across the isthmus. Placing the cost of constructing the Nicaragua canal at $133,000,000, the figures of the government board of engineers, the interest on this amount at 4%, would be $5,320,000. This implies a tonnage charge which would be prohibitory, accepting the estimate of tonnage made by Mr. Nimmo. If to the interest charge be added $1,500,000 per annum for cost of supervision, maintenance and operation, it is obvious that the enterprise would be very likely to be a losing one. Estimates for the Nicaragua canal based on the tonnage of the Suez canal are undoubtedly misleading, because the conditions affecting the two routes are very different. The Suez canal is the shortest route between the populous east and populous Europe. It is shorter also for ships bound from China for New York. It is in the line of an ancient stream of commerce, while Nicaragua lies between wide wastes of water.

THE MUNICIPAL OWNERSHIP OF ELECTRIC SUBWAYS.

It is now very generally admitted that overhead electric wires in our large cities are objectionable on many accounts, and the experience of some years has demonstrated that underground conduits are practicable for all classes of electric wires. But the ownership of the conduits where the wires are put underground is a question yet to be settled. Up to this time the practice in cities where wires have been laid in conduits is either to permit the electric light, telephone and other companies to do the work themselves or else to grant a franchise to a subway company to build and lease conduits under the more or less strict control of the municipal authorities as to rental, etc. The general result of the former practice is a useless multiplication of various systems of conduits, complications in the use of streets by rival companies and a rental charge that is excessive, when the possibilities of the case are considered, and which constitutes a heavy and needless tax upon the use of what is now an absolutely necessary means of intercommunication, light and power.

In the experimental stage of the effort to remove overhead wires the first cost of the construction of conduits and the uncertainty of their properly fulfilling all that was demanded of them deterred municipal authorities from assuming the risk of their construction, and at that time there was possibly good reason for caution in this connection. But the development of conduit construction and operation which has followed the trials and experiences of the last eight or ten years has practically removed these difficulties and risks, and the propriety of municipal ownership and absolute, as well as partial control is a proper subject for discussion.

While some cities, St. Louis for example, have the option of purchasing the conduits built by private companies at the end of the franchise term, Baltimore is, so far as we can learn, the first city to undertake on its own account the building and operation of a complete system of electric subways. Commencing without electric subways of any type, and benefiting by the experience of other cities, Baltimore has decided the question of ownership in its own favor, and the Maryland Legislature has authorized the city to expend $1,000,000 for this purpose, with the full approval of the citizens as expressed by popular vote. The reasons which have led to this conclusion are fully set forth in the several reports of Mr. Nicholas S. Hill, Jr., the Engineer of the Electrical Commission of Baltimore having that matter in charge. Mr. Hill has exhaustively investigated the subject of the operation and ownership of electrical subways in New York, Philadelphia, Chicago, St. Louis, Paris and London, and his last report especially is worthy of careful study.

The authorities quoted in this report very generally express the belief that the interests of the city are best subserved by municipal ownership of the conduits. Experience has demonstrated that the construction of such conduits by subway companies and their rental to electric companies, under charges nominally based upon the cost of building, has resulted in great inconvenience to all concerned. With conduits varying in type and efficiency, often located inconveniently, and originally built with money raised by individual effort with more or less difficulty, the resultant cost is unduly great and the rental charged is liable to be oppressive upon the users of electric service. There is always room for contention and complications between rival companies, which means in the end increased cost to the user of electric light. Moreover, it is certainly not good public policy for any municipality to enter into a permanent copartnership with private corporations in the use of public streets. This latter objection may be met by a franchise for a limited period, and provision for ultimate ownership on the part of the city; but the first objection of undue cost of service to the public still remains.

To confer a monopoly in conduit construction upon any one company, even under restrictions as to operation and rental, does not remedy the matter of cost; it does an injustice to somebody and is liable to result in serious complications and trouble to users. On the other hand, to grant franchises to a number of companies and to allow each to build its own conduits, is to bring about utter confusion and is directly opposed to the preeminent principle that the city alone can regulate and should maintain control of the space beneath the surface of its streets. Mr. Hill quotes the experience of St. Louis, under the last-named conditions, as showing that applications for permission to build conduits in that city, coming from 14 companies, cover almost every street and alley in the business portion of the city; and that on some of the streets a half-dozen or more companies want to build, and there is hardly a street which will not be occupied by at least two companies. The problem presented to the St. Louis Board of Public Improvement is a serious one, as each street and alley must be separately considered and the conflicting claims of rival companies and the complaints of property owners must be heard, and in some way adjusted. It may be said here, that the Board of Public Improvements may compel the joint use of conduits where two or more companies desire to use a single street. But telegraph and telephone companies, using low-tension circuits, vigorously object to having their wires placed near to, or even on the same side of the street with the wires of electric light companies using high tension. Existing underground obstructions add to the trouble of location. The plans for some of the conduits call for trenches 7 ft. deep where a network of gas-pipes lie only 2 or 3 ft. below the surface, with water pipes 4 ft. down and sewers and sewer connections below that. Cable roads contribute their obstacles to the general tangle, and the question of opening the streets for this conduit construction, without unduly inconveniencing traffic, and of restoring them again to their original condition without unduly taxing the citizens, is one yet to be solved.

In return for all this the city of St. Louis will, after Dec. 31, 1898, free a certain portion of the city from the obstruction of poles, wires and cables, will receive 5% of the gross receipts of the operating companies, and at the expiration of 15 years it may purchase the conduits and wires on terms fixed by ordinance. But the interests of the customers for telephones, electric light and power are considered in a single section, which provides that for this service they must not be charged in excess of the prices fixed for similar service on Jan. 1, 1896. There is no hope of lower rentals for 15 years at least, no matter how great may be the development of the system and the profit to the operating companies; in this the consumers have no share except in the increased percentage paid into the city treasury.

The experience of St. Louis is practically that of other cities, and though the scheme there has just been launched, the trouble ahead is already recognized, and the "Republic" of that city says that "the misfortune of not being able to have a general conduit system built under the control of the city is likely to become more manifest as the work of burying the wires progresses." Ownership of the subways by the city from the start seems to be the only proper solution for the problems involved. By this system alone can space be economized in providing necessary conduit room; the difficulties of construction properly adjusted to existing obstructions under the street surface, and the absolute control of these streets remain, where it belongs, in the hands of the municipal authorities.

As to the important question of profit to the city, in subway construction, Mr. Hill estimates as follows, after full investigation of the experience of other cities and of various electric light and power companies: That the amount of net revenue to be derived by the city from the building of a general system of subways would be equivalent to about 2% at the beginning. As the distribution of electric service increases, the sinking fund is replenished and the stock issued for construction is redeemed, the actual returns on the investment should be as much as 15 to 20%. As the city would not enter upon this business for individual profit, the increase in returns could be met by a decrease in rental charges to companies using the conduits, provided they would agree to share this saving with their patrons by granting lower rates. As to the alleged hardship of compelling companies to place their wires underground, the general result of Mr. Hill's investigations is that the increased cost of underground construction has as a rule been fully offset by the decreased cost of maintenance as compared with overhead wires, and the safety from interference by storm or accident is an additional important advantage.

In discussing the system of subway best adapted for this purpose, the large subway or tunnel, accessible by the workmen and also used for water and gas pipes, is objected to by Mr. Hill. He says that this type of subway, whether placed at the center or on both sides of the streets, is prohibitive on account of cost; does not obviate the tearing up of the streets for house service connections, and he does not deem it advisable to thus combine the gas, water and electric service in one system. He recommends, as meeting all the requirements of the case, the so-called "drawing-in" system of conduits, with tubes 2 or 3 ins. in diameter and with manholes at intervals of 200 to 350 ft. He has considered cement-lined conduits, wrought-iron pipes, the Camp and the McRoy terra-cotta conduit, and says that all four types have intrinsic merits. He adds that while wrought iron would be expensive, except for certain limited use, the three remaining types will give good results.

Mr. Hill admits the great diversity of opinion relative to the practicability of placing low and high potential wires in the same conduits, but he hints that there are other motives than those of difficulties of operation in the contention of the telephone companies that they cannot use the ducts which run alongside those carrying currents for arc lighting. His personal observation leads him to the belief that there is no real reason why all classes of service should not be placed in the same conduits, and he refers to the conclusions of the Electrical Commission of Washington as substantiating this belief. But in view of the fact that a combined system has not been generally used, he submits estimates and plans both for a separate and for a combined system. His preference is for the latter, as economizing space and reducing rental charges to the operating companies. He recommends, however, that before the construction of a general system is commenced, a hearing be given to the various Baltimore companies interested, to disprove the efficiency of the combined system. Various details of the work and the estimated cost of the systems proposed for Baltimore are given upon another page of this issue.

The departure from general practice in the construction and ownership of electric subways which

Baltimore now proposes will be watched with great interest by other cities. It is seemingly a long step in the direction of correctly solving what is now an exceedingly knotty question in more than one municipality.

LETTERS TO THE EDITOR.

The Action of Cinder Concrete on Steel.

Sir: As cinder concrete is being subjected to fire tests in connection with its use in fireproof floors, I would like to know if there is any data obtainable about the effect of cinder concrete on steel. Is it a preservative like the stone concrete, or has it any detrimental effect?

Yours truly, Thomas J. Foster.

2607-2627 So. Halsted St., Chicago, Ill., Jan. 19, 1897.

(We know of no experiments upon the effects upon metals of cinder used as a substitute for stone in concrete. When the ashes from boilers are moistened, the alkali, and possibly some remaining sulphur, have a corrosive effect upon iron. But we do not know that this would result from clean cinders embedded in hydraulic cement. We submit the question to any of our readers having practical experience on the matter.—Ed.)

A Clear Explanation of "Hammer Blow."

Sir: Enclosed find a clipping from the Westchester (Pa.) "Republican." "Is it any wonder that our County Commissioners are a little mixed on the question of stresses in a bridge when they rely on the newspapers for engineering and scientific information?"

Yours truly, B. M. K.

Phoenixville, Pa., Jan. 18, 1897.

(The clipping enclosed is as follows.—Ed.)

William E. Lockwood, of Glenloch, who is a director of the Pennsylvania Railroad, says the new iron trestle bridge over Pickering creek on the Phoenixville and West Chester branch, is not safe, and he predicts a disaster sooner or later. In speaking of the matter yesterday he had the following to say:

"The bottom stands perfectly still," said Mr. Lockwood, "and the top moves four times as fast as that standing still. In the first proposition it is the point where what is known as the hammer blow is struck. In the second, by virtue of that action, and by what is known as the centrifugal lift and tangetal throw the driver leaves the rail.

"It was not this mechanical action upon the Pickering bridge that caused the accident some time since," continued Mr. Lockwood, "because of the engine running backward. And the further fact that the wheels of the trucks had to turn three times to the driver's once. And this, with the weight of the water and coal lifted the tender from the tracks on the curve and caused the accident."

Cost of Asphalt Paving in Brooklyn in 1896.

Sir: The facts given below with regard to the asphalt pavement which was laid in Brooklyn during the year 1896 may be of interest to your readers, as I think that the cost of the work was exceptionally low.

The amount laid was 9.86 miles, at a total cost, including the removal of old pavement, regrading, foundation, curb, and everything except inspection and engineering, of $390,590. This does not include 3,806 ft. laid over old stone pavement by the Park Department, amounting to 13,302 sq. yds., and costing $19,230. Other details are as follows:

Average cost per mile, including curb and foundation	$39,614
	Per sq. yd.
Maximum price, asphalt surface (Railroad St.)	1.52
Minimum " " "	1.00
Average " " "	1.16
Maximum price, including foundation, curb, etc.	2.81
Lowest price, as above, with concrete foundation	1.97
Lowest price laid over old stone pavement	1.58
Average cost of all work done, including foundation, curb, etc.	2.04

The foundation consisted, in the majority of cases, of 5 ins. of Rosendale cement concrete, though in a number of cases the foundation was 6 ins. in thickness. The cost of the concrete varied from $3.60 to $4.20 per cu. yd., and the work was in almost all cases very satisfactory.

The largest proportion of the contracts were for Trinidad Pitch Lake asphalt, though Alcatras, Bermudes and Trinidad land asphalts were also laid. One of the contracts was for repaving a block upon which vitrified brick had been laid a year before, but owing to the numerous complaints of rumbling caused by vehicles passing over the brick, it was removed and asphalt substituted.

Yours truly, N. P. Lewis,
Engineer of Street Construction & Maintenance.

Brooklyn, N. Y., Jan. 19, 1896.

A Plate-Girder Highway Bridge.

Sir: I enclose herewith a photograph of the new highway bridge across the Ramapo River, at Hillburn, N. Y., which may be of interest to you. This bridge possesses no remarkable features, but is one of those rarities, a good substantial structure on a country road. It illustrates what can be accomplished by a little engineering supervision.

The girders are 84 ft. long over all and 7 ft. deep; the web is 5-16-in. thick. The flanges consist of two 5 × 5 × ½-in. angles and two cover plates 12 × ⅝-in. The bridge is divided into five panels. The floor beams are 30 ins. deep, with web plate ¼-in. thick and flanges of two 4 × 3 × 5-16-in. angles. The joists consist of six lines of 9-in. I beams, weighing 21 lbs. per foot, and two lines of 6-in. channels weighing 13¼ lbs. per foot. The only departure from the usual practice was the introduction of braces of plates and angles to support the top flange, imitating railroad construction.

The 9½° skew of the brick arch was a troublesome feature. It was finally laid with the courses perpendicular to the faces and running out to a knife edge on the skew backs. The centers were left in three months. No settlement was noticed when they were struck, nor has any occurred since. The bridges which these replaced consisted of a Howe truss across the river and a short span of timber beams across the raceway. As the bridges are situated at the foot of a hill, an arch was adopted to replace the short span, thus allowing the ascending grade to begin at the end of the plate girder. The girder bridge has a slight rise toward the hill, of 18 ins. in its length.

The Ramapo Iron Works which are located very near the bridge took sufficient pride and interest in the structure to offer to the Highway Commissioner, Mr. C. Irving Hopper, the services of the writer (their chief draftsman) who prepared the specifications and supervised the erection. The masonry was let to Thomas Dunwoody, of Hillburn, N. Y., for $1,525, and the iron work was furnished and erected by the Berlin Iron & Bridge Co., East Berlin, Conn., for $2,775. Yours very truly,

Wellington B. Lee.

Hillburn, N. Y., Jan. 15, 1897.

(We do not reproduce the photograph, as the bridge is sufficiently described by our correspondent's letter. We may add, however, that the bridge is a structure of pleasing appearance and is substantial enough to serve as a model to highway bridge designers. The use of plate girders in such situations is to be especially commended, and the advantage of competent expert advice is evident in substantial design and economy in cost. Other highway commissions and county authorities may well profit by the experience.—Ed.)

Earth Slopes in Tropical Countries.

Sir: While in the United States of America, my attention was called to Mr. Miller's letter, accusing me of not having carefully perused his letter in your issue of Jan. 25. Surely Mr. Miller's memory was at fault when he thus charged me with carelessness. Nicaragua Canal literature is deserving of a careful perusal, but Mr. Miller has evidently not given to his letter of June 25 the careful attention that he asks others to give. I have not been able to discover any one who can read Mr. Miller's article and tell where he refers particularly to the slope of railway excavations. All agree that Mr. Miller is clearly writing of canal construction, and even while he says that he did not intend to intimate that any such slope as ½ to 1 should be used on the Nicaragua Canal, he also says that he does not see why steep slopes might not be used above the water line.

I enclose you a view, on a railway in the tropics, in which you will see that the steep slope has slipped away and left the roots of the trees exposed, even the network of roots would not hold the slope. On this road it has been scarcely possible to keep the cut ditches open, and difficult to keep a clear track. The view sent you was not taken on the Tehuantepec Railway, but I may add that the slopes on that road also have been particularly difficult to maintain.

Since writing my letter of July 15, I have crossed the Isthmus of Panama, and was able to see something of the canal and railway excavations there. I have also crossed from the Atlantic to the Pacific, through Guatemala, and I have seen nothing to justify any hopes of economy in attempting steep slopes for the Nicaragua Canal, even above the water line. The natural slopes in the tropics appear even flatter than in the temperate zone, and if the Nicaragua Canal is ever built, it will be necessary to provide even flatter slopes than were provided for the Chicago drainage canal; and it would, I believe, be better to provide liberal slopes for the canal than spend money providing extensive harbors, for which there is no more necessity than there is for an extensive harbor at the mouth of the Mississippi River.

There is a monument on the line of the Mexican National R. R. marking the crossing of the Tropic of Cancer; many instances occur of passengers from the North becoming greatly excited on being told that they are about to cross this line; as they seem to expect an altogether different country on the south side of the Tropic of Cancer. Many attempts are made to create a wonderland of the tropics, and possibly the editor of the Engineering News has become affected, as he seems to take it for granted, that a slope is more stable at ½ to 1, than flatter, because it is in the tropics, when the real cause is in the material. It surely ought to be known that a trip to the tropics is not a necessity in order to see steep slopes that are stable. As to whether all the laws of nature are in force in the tropics, I will have more to say if Mr. Miller will state clearly which law of nature is not in force. Yours truly, Charles Thornton.

Guatemala, C. A., Jan. 5, 1897.

(The photograph referred to by Mr. Thornton shows the conditions described, but is unsuitable for reproduction. As to the reference to the editor of Engineering News, we simply referred as a curious paradox, to the statement made by Mr. Miller, "an engineer of much experience in tropical countries." The editor is well aware that material has very much to do with the case, in the Tropics as elsewhere; for while frost is totally absent in the regions referred to, the evil effects of this agency are in most cases fairly offset by an excessive rainfall. The prevalence in tropical regions of volcanic material, that has the appearance of earth, but is really a kind of hard-pan, standing at a steep slope has doubtless caused some of the misapprehension on this head that seems to prevail.—Ed.)

An Interesting Correspondence.

Sir: I send you herewith a letter and postal card from the Southwestern Construction Co., which I thought you might perhaps care to publish. If the President of the Construction Company may be believed, professional honesty among the engineers in his vicinity is at a very low ebb. Yours truly,

E. H. McHenry, Chief Engineer,
Northern Pacific Ry. Co.

St. Paul, Minn., Jan. 18, 1897.

(The letters enclosed by Mr. McHenry are as follows. We reprint them, "verbatim et literatim," and have commented on them below.—Ed.)

Kansas City, Mo., Jan. 9, 1897.

E. H. McHenry, Chief Engr., Northern Pacific R.R., St. Paul, Minn.

Dear Sir: The last Ry. Age states that your Co. intend building two extensions in the spring, one from Leeds north to Dunseith, the other from Edgeley west to the Missouri River. Now, we want a chance to figure on this work, all or any part of it. We are in the general construction business, and can make proper showing in every particular and furnish bond sufficient to insure the satisfactory completion of any work we undertake. We can perhaps make it to your interest to keep us posted, and are willing to reciprocate for assistance rendered, primarily, and subsequently. If advisable, our Mangr. would like a private confrence with you prior to putting in bid. Hoping to hear from you in the near future and that we may do some business through you, to our mutual advantage, we remain, Very resp.,

The Southwestern Construction Co.,
W. L. Powell, Pres't.

Mr. McHenry replied to this letter as follows:

January 12th, 1897.

Southwestern Construction Co., Whitney Bldg., Kansas City, Mo.

Gentlemen: Replying to yours of the 9th requesting an opportunity to bid upon construction work for the N. P. Ry. Co., it will not be necessary for your Manager to have a private interview with me, either at this or any other time. I take decided exception to the general tone of your letter. Yours truly,

(Signed) E. H. McHenry, Chief Engineer.

The following remarkable rejoinder, written on a postal card, closed the correspondence:

K. C., Mo., Jan. 15, 1897.

Dear Sir: Replying to yours of 12th inst., we are sorry we are too late in the field, and that we have "offended" you, thereby barring us from any chance of work with your company, but we will say, if your "decided exception" arises from any concientious scruples, aroused by any real or imaginary insinuations, you must stand alone in your class, and we are glad to know that such men exist in your profession. Yours truly,

The Southwestern Construction Co.
W. L. Powell, Pres't.

(We especially commend Mr. McHenry's course, not for his proper resentment of the insult offered him, for that was merely his duty and what any honest and honorable engineer deserving the name would do, but for sending the correspondence to us for publication. The letter of the President of the Southwestern Construction Co., winding up with his attack on the general reputation of the profession, is an excellent illustration of the fact that such men as he are the worst enemies of the engineering profession. Whenever their attempts are made in such an open and unblushing manner as in this case, a public advertisement of it in the columns of this journal is a punishment that admirably fits the crime.—Ed.)

THE NEW RAILWAY TERMINALS AT PROVIDENCE, R. I.

It is now nearly ten years since the subject of improved railway terminals at Providence, R. I., was first agitated and the work which was undertaken as a result of that agitation is now approaching completion.

To understand the problems which have been solved by the engineers in charge of this work some account of the peculiar local conditions is necessary. In the early years of the century there was in the outskirts of Providence a stretch of marshy land and a sheet of water, where the Woonasquatucket and Moshassuck Rivers united and formed the Providence River. This place (the water in which was subject to tidal range) was known as the Cove, and as the city grew it was decided to establish a circular basin and a park at this site. When the Boston & Providence R. R. (completed in 1835) desired to extend its line further into the city, in 1848, land was granted for terminals on the southeast side of the Cove, on condition that the railway company should build a segment of the masonry retaining wall for the basin, the water area of which was about 30 acres. Similar conditions were imposed on the New York, Providence & Boston R. R. when that road entered the city from the west, and the two railways then made a track connection and used the same station. The city authorities then completed the retaining wall and laid out an ornamental park, a dam being built below the basin to retain the water at the level of high tide. With the growth of the manufacturing interests and the discharge of waste and sewage into the rivers, the water in the basin became foul and unhealthy. The city had by this time grown up to and beyond the railways, and the increase of traffic on the railways practically cut off access to the park, the tracks crossing all the streets at grade.

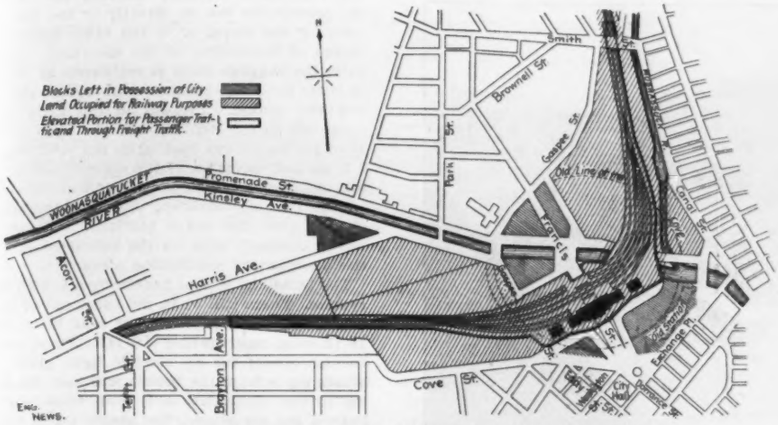


FIG. 1.—PLAN OF TERMINAL AT PROVIDENCE, R. I.; N. Y., N. H. & H. R. R.

In 1887 the Mayor, by direction of the municipal authorities, appointed a commission of engineers to report upon plans for new railway terminals, the commission being composed of Mr. Joseph M. Wilson, Mr. Don J. Whittemore and Mr. Alfred P. Boller, all members of the American Society of Civil Engineers. The plan proposed by this commission, as described in our issue of April 27, 1889, was to fill in the Cove and lay out the land as a park, and to place the through tracks and a passenger station along the north side of this land, with separate freight terminals for the several railways. All grade crossings were to be removed. The plan, however, was not adopted by the municipal authorities, but it was decided to build masonry channels for the two rivers, connecting at a point beyond the old basin, and then to fill in behind the walls of these channels with gravel. The contract for this work was let in September, 1888, to James J. Newman, of Providence, R. I., at $193,921. Other expenses made the total expenditure by the city about $100,000 more. The work was under the charge of the City Engineer, with Mr. Wm. D. Bullock as Assistant Engineer and Mr. Henry N. Francis as Resident Engineer.

In July, 1888, directions were given to Mr. S. L. Minot, Engineer for the Old Colony R. R. and Boston & Providence R. R., and Mr. E. P. Dawley, Chief Engineer of the New York, Providence & Boston R. R., to examine and report upon plans for terminal facilities, and they devised a plan which was adopted, and is now being carried out, with some modifications. This is shown in Figs. 1 and 2. The plan consists in replacing the present sharp curve south of the old Cove by an easier curve across the Cove, the land being all filled in and a station built upon this site; the tracks are elevated, all grade crossings being abolished, but the station and platform are reached by roadways of easy grade, without the use of steps. The plan of the new terminals was given in our issue of Aug. 2, 1890, but the design for the station building shown in that issue was not adopted. The above is a brief general statement of the steps taken to improve the railway facilities and eliminate the grade crossings, but a more detailed history will be found in a paper by Mr. S. L. Minot in the Journal of the Association of Engineering Societies, 1890.

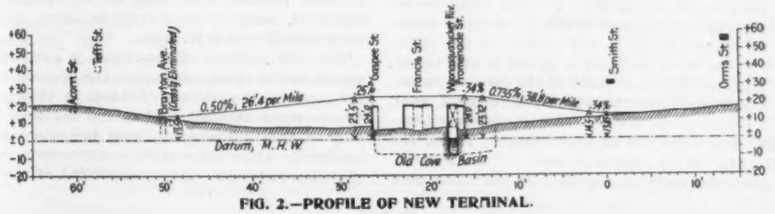


FIG. 2.—PROFILE OF NEW TERMINAL.

The acquisition of the two railways above mentioned by the New York, New Haven & Hartford R. R. Co. considerably simplified matters, both in regard to the policy of the work and the details of construction. This road and the New England R. R. are now the only two which will use the station, and the latter is now controlled by the N. Y., N. H. & H. R. R. Co.

The city filled in the land at the Cove and sold it to the railway company at $1.25 per sq. ft. for about 41 acres so transferred. The land now occupied by the old tracks and station will be bought back by the city at $4 per sq. ft., including the buildings thereon, and this land will probably be cleared and laid out as a park. Land for the freight yards was sold to the railway interests at 75 cts. to $1 per sq. ft. In all 41 acres of land have been purchased by the railway from the city, and the city has purchased 3 acres of land formerly used by the railway. In addition to land purchased from the city, large areas of land have been acquired by the railway interests from other parties, so that the present railway land holding between Acorn St. and Smith St. amounts to 70 acres, or about double the former area.

A considerable portion of the new line of the railway is built on steel bridging, with solid floors, while a stretch of embankment at each end of the new work connects with the present grade. There is no less than 75,000 sq. ft. of bridge work in the railway part alone, and with the new bridges constructed by the city as part of the system the total bridge area is nearly 200,000 sq. ft. The bridge over the Woonasquatucket River and Promenade St. (with 12 tracks) has 47,500 sq. ft.; the Gaspee St. bridge (12 tracks), 17,000 sq. ft.; and the station proper (with tracks and platforms), including the bridge over Francis St., has 95,000 sq. ft. The bridges over Gaspee St. and Promenade St. are of box plate girder construction. The 100-ft. skew bridge over the river is a deck bridge with pin-connected trusses, most of the trusses being square across the river, while the end trusses are skewed to the required line of the bridge.

The Gaspee St. bridge and the style of solid flooring used (designed by Mr. E. P. Dawley and Mr. Geo. B. Francis) were illustrated in our issue of Nov. 15, 1894. As shown in Fig. 3, it is a trough floor, with bottom joints, so that the bottom is tight, the troughs resting on shelf angles on the webs of the girders. Drainage holes are drilled near the ends, and gutters and leaders are placed under these. All ironwork is painted with red lead, and the floor is given a coating of asphalt composition containing about 20% of crude petroleum to render it soft and tough. The troughs are filled with clean coarse gravel, over which asphalt is poured, and upon this filling is placed the broken stone ballast. A substantial coating of asphalt mastic, two or three inches in thickness, is put over the tops of the girders to protect them from abrasion by the ballast. The Berlin Iron Bridge Co., of East Berlin, Conn., had the contract for the Gaspee St., Promenade St. and Woonasquatucket River bridges, but sublet the latter to the Pencoyd Construction Co., of Pencoyd, Pa. The Pennsylvania Steel Co., of Steelton, Pa., had the contract for the Francis St. bridge. The Boston Bridge Works, of Boston, Mass., also had a contract for bridging over Francis St. under and in front of the station.

Fig. 4 is a view of the 1½ acres of solid floor of the Francis St. bridge, 335 ft. 6 ins. long and 202 ft. 6 ins. wide. The bridge is composed of 11 plate girder spans resting on built-up steel columns of I section, connected by latticed struts, The center span, which extends over part of Francis St., is 43 ft. c. to c.; the others are 29 ft. 3 ins. c. to c., and are arranged symmetrically to the street. All the spans are of deck construction, with the exception of one span about 60 ft. from the street itself on each side of Francis St., these being half-through spans in order to give the necessary headroom for the subways connecting with the platforms and the street below. These half-through spans show very clearly in the cut, and the openings in the floor are for the stairways to the subways. At present there is provision for ten tracks on the structure, between which are the platforms and light areas, with the stairways.

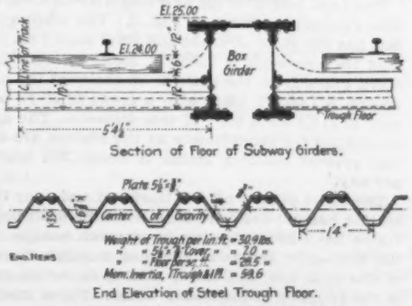

El. 25.00
El. 24.00
Box Girder
Trough Floor
5'4⅛"
Section of Floor of Subway Girders.
Plate 5⅛"x⅜"
Center of Gravity
14"
Weight of Trough per Lin. ft. = 50.9 lbs.
" = 5⅛" x ⅜" Cover, " = 7.0 "
" = Floor beam, " = 28.5 "
Mom. Inertia, Trough & Flr. = 59.6
End Elevation of Steel Trough Floor.

Fig. 3.—Style of Solid Floor Used.

Provision can readily be made for additional tracks. The foundations of the main station building are to be seen on the left hand side of the picture, and beyond these are some cars standing on the present tracks, just beyond the old station. Fig. 5 is an elevation looking along Francis St., showing the flooring and also (on the right) the plate girders to support the subway.

The construction is substantial looking enough, but would have been of more pleasing appearance if knee braces of an easier curve had been

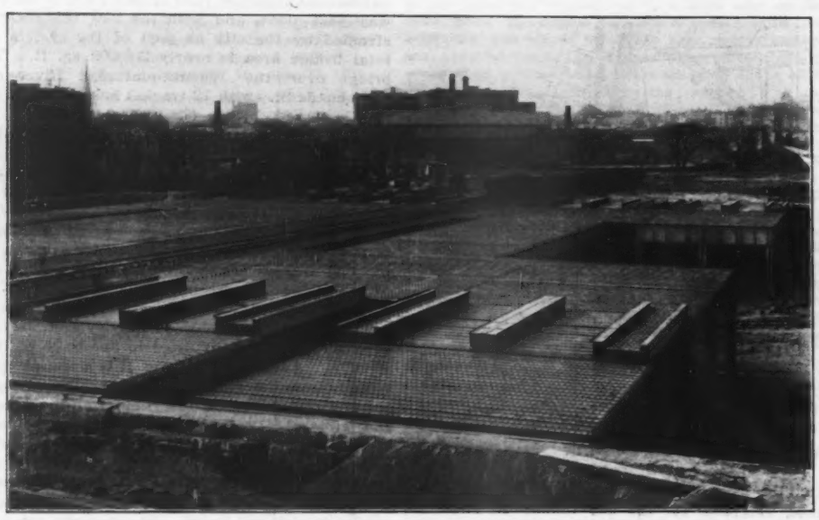


FIG. 4.—VIEW OF THE STEEL FLOORING (1½ ACRES) OF THE FRANCIS STREET BRIDGE FOR THE NEW TERMINALS AT PROVIDENCE, R. I. Pennsylvania Steel Co., Builders.

used, and if the flanges of these braces had been carried down to connect with the webs of the columns, instead of being cut off blunt and square.

The solid flooring used on the main part of the Francis St. bridge is shown in Fig. 3, with a cross section at the subway girders. The dimensions, etc., of this floor are as follows:

Thickness of sides of trough	⅜-in.
Thickness of bottom of trough	⅜-in.
Weight of trough per lin. ft.	30.9 lbs.
Weight of cover plate, ⅜ × 5½ ins., per lin. ft.	7.0 "
Weight of floor per sq. ft.	28.5 "
Moment of inertia of one trough and one plate	50.6
Depth of trough over all	6 ins.
Length over flanges	15½ "
Length on bottom	3 "
Length of each flange	2½ "
Radius of fillet curves, top and bottom	⅜-in.
Height to c. of gravity of trough and cover plate	3½ ins.
Distance c. to c. of floor troughs	16 "

The earth filling for the approach tracks west of Gaspee St. amounted to about 80,000 cu. yds., most of which material came from near Roger Williams Park, at a point about 5 miles out on the main line, where the removal of this material gave opportunity to reduce quite a long curve from nearly a 6° to a 2° curve. This improvement was completed in the summer of 1896.

The total length of the new line is about 5,000 ft. The grades are shown in Fig. 2. The station itself has 500 ft. of straight and level track; on the east the approach is 2,300 ft. long, with a 0.5% down grade from the station; on the west the approach is 1,600 ft. long, with a grade of 38 ft. per mile (0.71%) for a part of this distance. The approach curves immediately at the station are 9°. The present summer traffic is about 200 trains per day.

The exact plan of all the tracks at and near the station has not yet been definitely settled. Freight trains have been running for several months on the two outer tracks of the four through tracks of the new line, the easier grades on which are in the direction of the loaded trains. These tracks are laid with 100-lb. rails. The railway has four tracks for the entire length of the improvement.

An extensive shelter attached to the buildings, with a large low ridge and furrow roof, will cover the wide main platform, and shelter roofs will cover the island platforms and the platform between the stub tracks.

The station arrangement is of somewhat novel design, as shown by the general view, Fig. 6. There are five separate buildings, three of which are connected by colonnades or roofed passages and form the station proper. The central building is 220 × 110 ft., one story high, and contains the waiting rooms, toilet rooms, ticket offices, etc. On each side, and connected with the main building by a colonnade, having a roof supported by columns of polished Leete's Island granite, is a building 72 × 84 ft., two stories high. The one on the east is for baggage and the one on the west for a restaurant. Beyond these two small buildings are two separate four-story buildings, 125 × 65 ft., the one on the east being for express matter and the one on the west for general offices of the divisions centering at this point. The general plan is shown in Fig. 7. The total length of the group of buildings is 870 ft., and the width is from 65 to 110 ft. In the middle of the street front of the main building is a low heavy tower, with a porte-cochere in front of the main entrance.

The buildings are of speckled yellow brick, with North Connecticut Valley red sandstone trimmings. The roofs are of sheet copper, 16 oz. per sq. ft., and 18 oz. copper is used for the gutters. The platform shelters attached to the track side of the station buildings are also covered with copper, and there will be in all over three acres of copper roofing. In the office and express buildings the columns and main floor girders are of steel, and the inner partition walls of brick, while the floors are of slow-burning mill construction, with hard pine beams and mineral wool packing between these beams and the double floors. Brick vaults and safes are provided on each floor of the office building. On the ground floors all the paving is of concrete, with marble mosaic covering in the waiting room, wood in the smoking room and women's room, cement in the toilet rooms and asphalt in the subways under the tracks. The station buildings cover an area of 62,000 sq. ft., including the main platforms. The central building has a floor area of 25,500 sq. ft.; restaurant and baggage room, 5,900 sq. ft each; office and express buildings, 7,500 sq. ft. each. The main waiting room is 218×60 ft., and the restaurant and baggage room are each 70 × 70 ft.

Fig. 8 is a longitudinal section of the three central buildings. Persons entering the station at the colonnades can go directly to the main platform by the steps, or to the other platforms by means of the incline to the subways. They can enter the baggage room or restaurant by the steps, or enter the main waiting room by the side doors and the incline. Persons in the main waiting room can go directly out onto the main platform, or to the stairways leading to the subways. Fig. 9 is an end elevation of the main building, showing the porte-cochere or covered way for carriages at the central entrance, and also the platform shelter over the main platform. The subway shown connects with all the buildings, and is for the heating and ventilating pipes, etc.

The buildings will be heated by a hot air blower system. There will be in the basement of the restaurant building a battery of four 72-in. boilers, 18 ft. long, aggregating 500 HP. These will also furnish steam for an electric light plant. The steam pipes from the boilers will heat the several air intake chambers, and from these chambers extend the air pipes. The steam pipes, etc., are connected between the several buildings through subways or tunnels, and also pass over Francis St. in an overhead passage or pipe-way concealed in the thickness of the bridge girders. The fresh air will be discharged through registers in the rooms, and the vitiated air drawn off by exhaust pipes near the ceilings. The fans may be driven by steam or electric power. Coal chutes are provided, so that coal can be shovelled directly from cars into the basement, while the basement openings (on the street level) are wide enough to enable coal wagons to be hauled right into the building if necessary. The main covered platform, next to the station building, is 400 ft. long and 40 to 100 ft. wide.

The arrangement of roadways is somewhat peculiar, and is designed to give the greatest facility for access to the station. Francis St. (100 ft. wide) passes right through and under the station, and wide spaces opening off from the sidewalks immediately under the station communicate with the platform subways. Along the front of the building is a broad roadway, sloping down easily at each end to the street level, this roadway crossing Francis St. by a bridge, on which is the porte-cochere of the main entrance. On each side of Francis St., and rising from the level of the street to that of the approach roadway is a 70-ft. carriage road with sidewalks. In most large stations the bulk of the passengers have to pass through the waiting room, even if they are going directly to or from the trains, and have not to buy

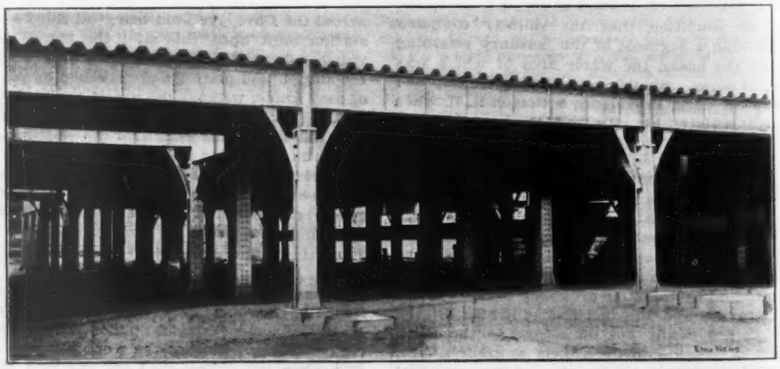


FIG. 5.—VIEW OF FRANCIS STREET BRIDGE, PROVIDENCE, R. I.; N. Y. N. H. & H. R. R

tickets or transact other business. In this station, however, it is estimated that 60 to 70% of the passengers will use the side entrances to the platform, through the colonnades, thus avoiding interference with the passengers using that room, which is a very desirable end to be attained. The waiting room is slightly above the level of the colonnades, and this difference in elevation is overcome by easy inclines of about 6% grade, as shown in Fig. 8, while similar inclines lead from the colonnades to the subways under the tracks. Stairways lead from the subways to the platforms above and to Francis St. below. By these arrangements it is expected that the present traffic may be increased very considerably before any crowding is felt, while the possibility of adding to the number of through tracks provides for an increase in trains.

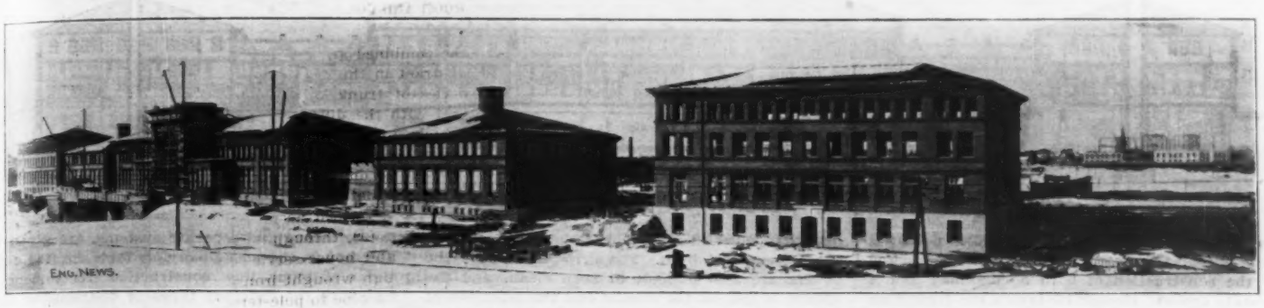


FIG. 6.—PERSPECTIVE VIEW OF NEW TERMINAL STATION AT PROVIDENCE, R. I.
Stone, Carpenter & Willson, Architects.

The buildings are all on pile foundations. The piles are of spruce, 40 to 45 ft. long, 30 to 36 ins. c. to c., driven in double and triple rows under the walls. As the material through which they are driven is so soft, horizontal struts or braces are placed across the panels to prevent the lines of pilings from being bent in. The piles are cut off about 4.50 ft. below high water, low tide level being 4.83 ft. below high tide. On the piles are 12×12-in. caps, with a close flooring of hemlock planks 6 ins. thick in ordinary cases, and 8 ins. thick under heavy masonry. The foundation walls are mostly of granite rubble masonry, and rest directly on the flooring.

To facilitate the work of construction an extensive system of service tracks was laid over the work is under the direction of Mr. F. S. Curtis, M. Am. Soc. C. E., Chief Engineer of the New York, New Haven & Hartford R. R. Our acknowledgments are due to Mr. Dawley and to the architects and the Pennsylvania Steel Co. for views and blue prints, etc. The general contractors for the buildings, etc., are Hortons & Hemenway, of Providence, R. I. They commenced work early in 1896 on top of the heavy foundations previously prepared by the railway company, and by December all the buildings were roofed in. It is expected that in the coming summer the station buildings and approach tracks will be ready for occupation.

It is rather difficult to state precisely the entire cost of the whole work, as a large amount of necessary outlying construction, including also expensive land acquired, was done a year or two ahead of the central and more conspicuous part of the work. One item was a widening of a deep cut immediately at the north end of the new passenger approach tracks from a capacity of two tracks to six tracks. Other items are large passenger and freight yards added to and reconstructed on account of the approaches to the new station, demolishing the former arrangements of that character; also a new channel for the Mosshassuck River about 350 ft. long, with continuous track-bridging over it. The entire cost of the work, however, including cost of land, can be properly stated at about $3,400,000. Of this amount the city may be stated to have expended 20% in river walls, filling, street bridges, etc. In one respect the work may be considered virtually a new lay-

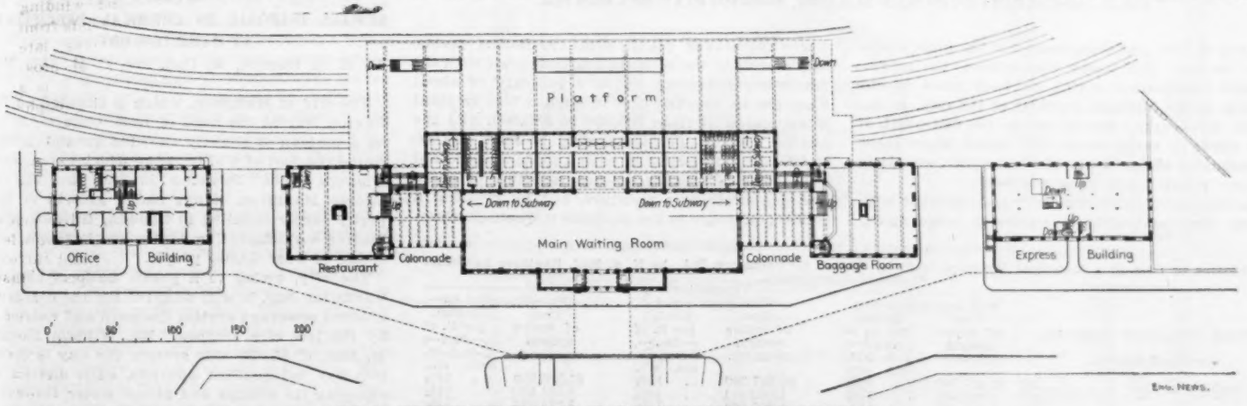


FIG. 7.—FIRST FLOOR PLAN OF STATION BUILDINGS, PROVIDENCE, R. I.

site, and this resulted in reducing the contract prices, as all material is delivered on cars at points where it can be handled directly by derricks.

There has been ample provision made for freight yards for both railways to the east and west of the passenger station.

The general and detailed plans of the terminal arrangements were made by Mr. E. P. Dawley, M. Am. Soc. C. E., Division Engineer of the New York, New Haven & Hartford R. R., and Mr. George B. Francis, M. Am. Soc. C. E., now Resident Engineer of the Boston Terminal Co. The architects of the station are Messrs. Stone, Carpenter & Willson, of Providence, R. I. All the out and reconstruction of a very large tract in the center of a large city, and other street layouts and railway improvements needed to round out the project may carry up the total expenditure to nearly $4,000,000.

THE PROPOSED MUNICIPAL ELECTRIC SUBWAY SYSTEM OF BALTIMORE.

The city of Baltimore has decided to build its own system of electrical subways and to lease them to telegraph, telephone and electric light and power companies upon terms leaving the control of the streets and subways in the hands of the municipal authorities. A lately issued report of Mr. Nicholas S. Hill, Jr., Engineer of the Electrical Commission of Baltimore which has this work in charge, contains the general scheme proposed, the rules and regulations adopted governing the use of the municipal subway system, and a statement of the practice in other cities, here and abroad. From this report the following brief abstract is made:

Mr. Hill recommends the creation of a permanent electric commission to be placed in charge of all electrical construction in the city, with power to formulate and to enforce such rules and regulations as it may deem necessary for electrical construction of all kinds. He decidedly favors the municipal ownership of all conduits for whatever purpose proposed, and outlines the area of the city in which wires should be placed underground. He recommends that the municipal subway should be built at least 50% larger in capacity than the present service requires to allow for the growth of business.

He objects to the large subway or tunnel system, accessible to workmen and utilized also for water and gas pipes, as being prohibitory in first cost and as not meeting the conditions required. He advises the adoption of the "drawing-in" system of 2 to 3-in. ducts, packed in nests or used singly, with wires or lead-covered cables drawn into the ducts after the present practice. He advises the Camp or McRoy terra-cotta conduit for trunk lines. The first is manufactured by the B. H. Camp Co., of Greentown, O., and is made of vitrified clay, salt-glazed on the inner and outer surfaces. This is a single 3¼-in. duct with rectangular and grooved exterior. These tiles, in 18-in. lengths, can be assembled in any number of ducts required and are laid up in cement mortar with a ¼-in. space between the tiles. When laid the group of ducts is surrounded by a shell of cement concrete from 4 to 6 ins. thick. The McRoy terra-cotta conduit is made by John T. McRoy, of Chicago, Ill. The material used in their manufacture is finely ground shale, and the conduit is of the multiple type, with from 2 to 12 ducts, and in any length from 4 to 6 ft.; it is glazed inside and out. These conduits are also to be surrounded by concrete, and sections can be

assembled and laid in cement mortar so as to provide any number of ducts required. For certain purposes Mr. Hill also recommends cement-lined conduits, in 8-ft. lengths, and wrought-iron pipes spaced 5¾ ins. apart and laid in concrete. In comparative cost the Camp conduit is somewhat the cheapest, with the McRoy conduit next; the wrought-iron pipe is, of course, the most expensive.

Owing to the diversity of opinion regarding the practicability of using high and low potential wires in the same conduit, Mr. Hill presents plans for the construction of both a combined and a separate system; though he favors the former as being practicable and cheaper. In the separate system he places conduits for telegraph, telephone and other low potential circuits on one side of the street, and electric light and other high potential wires on the opposite side. For the combined system of conduits he would use a combination of 2-in. and 3-in. ducts; as the 2-in. ducts cost less per foot and are large enough for cables designed for light service. If the separate system were decided upon, he would use all 3-in. ducts for the low potential circuits, and a combination of 2-in. and 3-in. ducts for the high potential circuits. For house connections he recommends distributing mains on both sides of the streets in the business portions of the city, to obviate the necessity for tearing up the full width of the street in many cases. He would place these distributing mains under the sidewalks, except in streets where trunk lines are used.

As the soil in cities is usually impregnated with gases, some of which are explosive when mixed with air, Mr. Hill proposes to ventilate his conduits. Perforated manhole covers, of special design, are objectionable, as in many cases the gases are either heavier than air or the same specific gravity and the small perforations in the cover do not give sufficient circulation to remove the gas. These openings then become an element of danger, as a lighted match, a cigar or a coal from a passing fire-engine might drop through the opening and cause an explosion; as more than once happened in New York when the conduits there were first built. The drip-pans under the covers are also difficult to keep clean, and the escape of gas on the streets and the retention of offal in the pans in hot weather are unsanitary features, to say the least. The second method of ventilating conduits by stand-pipes, placed opposite to, and connected with the manholes, may be adopted in certain cases. But these pipes do not furnish sufficient circulation when gas is present in large quantities, and they mar the appearance of the streets and discharge foul air near the windows of dwellings.

Mr. Hill recommends, as a more expensive but much more efficient plan, ventilation by means of a central blower plant, with ventilating mains, laid alongside the conduit and connected with the manholes, delivering air at a pressure of about 6 oz. per sq. in. The cost of such a blower plant is estimated at from $60,000 to $80,000, and the annual cost of operation would be from $15,000 to $20,000. The action of such a system would not only serve to prevent the accumulation of gases and evaporate any moisture, but by creating a counter-pressure in the conduits it would positively prevent the ingress of gas and water. Mr. Hill compares the cost of the three systems of ventilation as follows:

	Cost.	Interest and maintenance. No additional cost.
1. Perforated covers		
2. Stand-pipes:		
Combined system	$10,000	$1,200
Separated system	19,276	2,313
3. By compressed air:		
For either system	60,549	15,462

The estimated costs of constructing a system of subways, within the areas laid down and for both the combined and separate systems, are given in abstract in the accompanying table for the four styles of trunk line construction recommended and with the different types of distributing and ventilating systems mentioned, together with the estimated rentals to be charged:

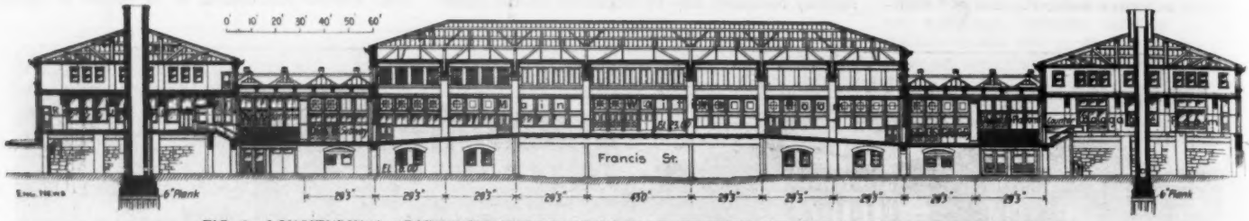


FIG. 8.—LONGITUDINAL SECTION THROUGH WAITING ROOM, RESTAURANT, BAGGAGE ROOM AND COLONNADES.

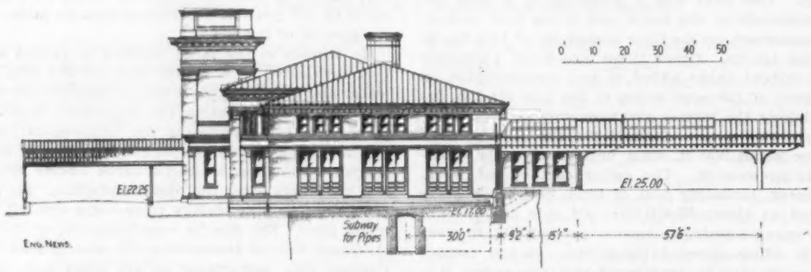


FIG. 9.—SIDE ELEVATION OF MAIN BUILDING, SHOWING PLATFORM SHELTER.

In the accompanying table the types (a) and (b) apply to methods of house service distribution and are described as follows: For telegraph and telephone, (a), through Cummings and Engelman conduit and house-service boxes to subscribers; (b), through wrought-iron, cement-lined tubes, or terra-cotta pipe to pole-terminals situated in each block, and thence overhead to each subscriber. For electric light and power lines; (a) through wrought-iron pipes and house-service boxes to each consumer; (b) all companies except the Edison Co., as above, the Edison Company through Edison mains. The exact number of lineal feet of conduits, or ducts, covered by the estimate is not given; but the area to be improved practically covers the whole business portion of Baltimore and is equivalent to a space about 1¼ miles square.

It is not too much to say that this report of Mr. Hill constitutes about the best treatise in existence upon the important subject of electrical subway construction and management, and any of our readers interested in the subject are advised to secure a copy for their own libraries if possible.

Estimates of Cost of a Municipal Electrical Subway System for Baltimore, Md., by N. S. Hill, Engineer Baltimore Electrical Commission.

Trunk-lines—Style of conduit.	Ventilation. With manhole covers. Cost of entire system complete.	Rental, per ft. of duct 2-in.	Rental, per ft. of duct 3-in.	Ventilation. With stand-pipes. Cost of entire system complete.	Rental, per ft. of duct 2-in.	Rental, per ft. of duct 3-in.	By compressed air. Cost of entire system complete.	Rental, per ft. of duct 2-in.	Rental, per ft. of duct 3-in.
Combined System.		cts.	cts.		cts.	cts.		cts.	cts.
Wrought-iron pipe .....(a)	$1,437,360	..	13¾	$1,447,360	..	13¾	$1,506,909	..	14½
" " " .....(b)	1,022,321	..	10¼	1,032,321	..	10¼	1,091,870	..	11½
Cement-lined pipe .....(a)	1,205,064	..	11	1,215,064	..	11¼	1,274,613	..	12¼
" " " .....(b)	790,025	..	8	800,025	..	8	859,574	..	9¼
McRoy tile, 3-in. .....(a)	1,130,373	..	10½	1,140,373	..	10½	1,199,922	..	11½
" " " " .....(b)	715,335	..	7¼	725,335	..	7¼	784,884	..	8½
Camp tile, 3-in. .....(a)	1,108,983	..	10¼	1,118,983	..	10¼	1,178,532	..	11¼
" " " .....(b)	693,945	..	7	703,945	..	7	763,494	..	8¼
McRoy tile, 2 and 3-in.....(a)	1,076,291	7¾	11½	1,086,291	7¾	11½	1,145,840	8¾	12¾
" " " " .....(b)	661,253	5¼	8	671,253	5¼	8	730,802	6¼	9¼
Camp tile, 2 and 3-in.....(a)	1,063,594	8¼	11	1,073,594	8¼	11	1,133,143	9¼	12
" " " " .....(b)	648,556	5½	7¼	658,556	5½	7½	718,105	6¾	8½
Separate System.									
Wrought-iron pipe .....(a)	1,476,361	..	13¾	1,495,637	..	14	1,545,910	..	15
" " " .....(b)	1,104,757	..	11	1,124,033	..	11	1,174,306	..	12¼
Cement-lined pipe .....(a)	1,256,512	..	11¾	1,275,788	..	11¾	1,326,061	..	13
" " " .....(b)	884,908	..	8¼	904,184	..	9	954,457	..	10
McRoy tile, 3-in. .....(a)	1,176,603	..	11	1,195,879	..	11	1,246,152	..	12
" " " " .....(b)	804,998	..	8	824,274	..	8¼	874,547	..	9¼
Camp tile, 3-in. .....(a)	1,157,125	..	10¾	1,176,401	..	11	1,226,674	..	12
" " " .....(b)	785,521	..	7¾	804,797	..	8	855,070	..	9
McRoy tile, 2 and 3-in.....(a)	1,113,891	7¼	13¼	1,133,167	7¾	13½	1,183,440	8¾	14½
" " " " .....(b)	742,287	5¼	9¼	761,563	5¼	10	811,836	7	11
Camp tile, 2 and 3-in.....(a)	1,105,255	7¼	13¼	1,124,531	7¼	13½	1,174,804	8¾	14½
" " " " .....(b)	733,650	5¼	9¼	752,926	5½	9¾	803,199	6¾	11

SEWAGE DISPOSAL BY CHEMICAL PRECIPITATION AT HAMILTON, ONT.

By E. G. Barrow, M. Can. Soc. C. E., City Engineer.

The city of Hamilton, which is situated on Burlington Bay at the head of Lake Ontario, is built on a plateau of slightly elevated ground, winding round the foot of a hilly range which extends from Niagara Falls. Founded in 1813 by the late George Hamilton, it has had a growth of prosperity rarely equalled in Canada, till now it is a leading manufacturing center and boasts a population of over 49,000 people.

The city, owing to a gentle uniform slope towards the bay, is well adapted for the ample and efficient sewerage system designed and carried out by the late city engineer, Mr. William Haskins, M. Inst. C. E. By this system the city is divided into five independent districts, each district discharging its sewage and storm water through a main outlet into Burlington Bay, as shown by the map, Fig. 1. For a number of years the bay, which is about six miles long by two miles wide, was fully capable of disposing of the sewage thus discharged, till recently, owing to the increase in the size of the city, the waters were gradually getting polluted, especially along the shore line. In the year 1895 matters were brought to a climax by an order from the High Court restraining the city from discharging crude sewage at the east end outlet, on the ground of its being a nuisance; the sewer in this district emptying into an inlet from the bay and not into the bay directly.

The late city engineer, Mr. Haskins, recommended the purification of the sewage by chemical

precipitation, and advised the construction of such works at the outlets of two of the trunk sewers at Ferguson Ave. and the east end. A by-law being submitted to the ratepayers was carried for the construction of this work, the amount voted being $50,000 for the Ferguson Ave. outlet and $35,000 for the east end outlet. It will thus be seen that the character and location of the works are both in accordance with the recommendation of the late city engineer.

The question of applying the sewage to land was gone into, but no site of a suitable nature or at a reasonable cost could be obtained and there was a determined opposition made to the establishment of sewage farms by the surrounding townships.

The question of collecting all the sewage of the city at one station was also discussed, but was found to be too expensive, the estimated cost being about $200,000.

After careful measurements the daily dry weather flow of sewage at the east end outlet, where the works are being established, was found to be 500,000 gallons per 24 hours. Owing to the fact of the rapid increase in the population of this district, and the building of several trunk sewers in connection with it, the works are being constructed on a larger scale than would otherwise have been considered necessary. The works at the west end will not be nearly so expensive, as the sewage will be treated by gravitation, the outlet being sufficiently high to dispense with the pumps. The sewage is comparatively free from obnoxious components, being largely collected from the rural parts of the city.

The works now being constructed consist of a pump house, press house, three large precipitation tanks with channel leading from the pumps, mixers and other accessories, all shown in plan by Fig. 2. The sewage after passing through a screen enters the receiving well, Fig. 3, where it is mixed with the proper proportions of lime and sulphate of alumina, and is then raised by two centrifugal pumps into a channel 4 ft. wide, Fig. 4. This pumping is rendered necessary by the outlet of the sewer being almost on a level with the waters of the bay. In passing through the centrifugal pumps the chemicals are thoroughly mixed by the churning action of the pumps. The sewage is conducted in the channel to the precipitation tanks, shown in plan by Fig. 1, and in section by Fig. 5, which are each 44 × 103 ft., where the sludge settles at the bottom. One or more of these tanks can be disconnected from the rest, when the sludge precipitated at the bottom requires removal, by closing the weirs leading to such tanks. The water is then drawn off by skimmer pipes, after which the sludge is conducted by means of a small open drain underneath the main channel to the sludge well. Here any water which may collect on the surface of the sludge is pumped out by a small auxiliary pump, and the sludge itself is then pumped into a press or into wagons direct. From the press it is turned out in the form of cakes which are dropped on trucks, running on rails, and thence conveyed outside the building. There are two chemical mixers operated by the pumps, and the effluent after being aerated by falling down steps is conducted by an 18-in. pipe into the bay.

The works are being built under the direction of the writer, as city engineer. Before laying out the works the writer made special visits to the different cities where similar works have been constructed, and everything which has proved unsuitable has been omitted and several improvements substituted. Mr. Charles Wallace was the assistant engineer in charge of the works, and it is due to his instrumentality that they were so correctly and substantially built.

The works were put under construction in July, 1896. On Jan. 22, 1897, the tanks had been finished and the machinery was being put in place, with the expectation that the plant would be finished in about a month.

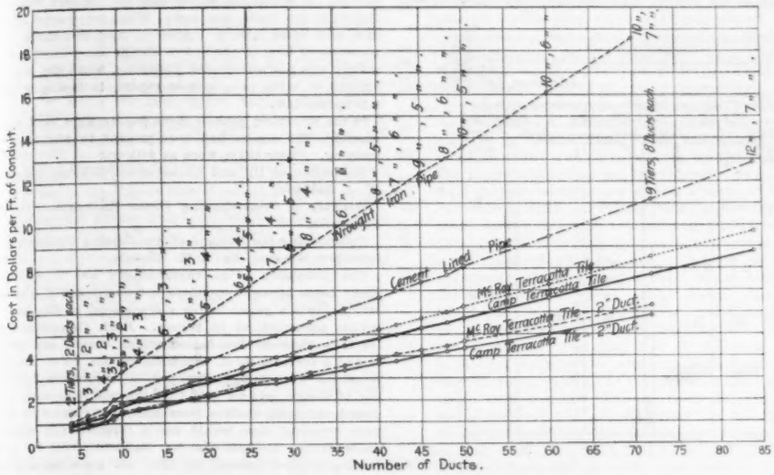


DIAGRAM SHOWING THE COST IN DOLLARS PER FOOT OF DUCT OF ELECTRICAL SUBWAYS OF VARIOUS CAPACITY LAID UNDER BELGIAN BLOCK PAVEMENT IN BALTIMORE.

THE TRANSVERSE CRUSHING STRENGTH OF timber was recently investigated by Mr. Oscar Lowinson, Jun. Am. Soc. C. E., 39 Cortlandt St., New York city. The object was to obtain working values of the transverse crushing strength of timbers as used in buildings where bolsters and girders are sandwiched between columns, beam ends, or at the caps of trestle bents and the connection of posts to chords in wooden trusses, etc. The tests were made with a Riehle 100,000-lb. machine in the laboratory of Dr. Chas. F. McKenna, and the results showed an ultimate resistance to crushing somewhat below that which is ordinarily used. The results of the tests on material free from knots gave the following as the average load at which fibers failed:

Yellow pine (new)	400	lbs. per sq. in.
" " (old)	774	" " " "
White pine	550	" " " "
Oak	1,200	" " " "

The tests were comparatively few in number, however, and Mr. Lowinson suggests the need of a large number of tests to obtain sufficient data for reliable working values.

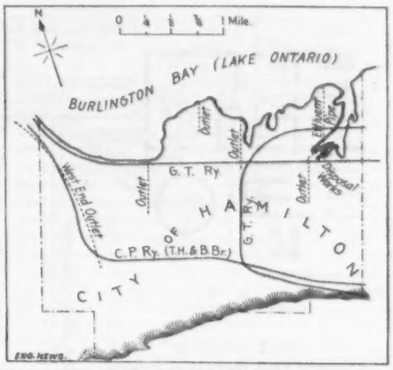


Fig. 1.—Map of Sewage Disposal Works and Sewer Outlets at Hamilton, Ont.

E. G. Barrow, City Engineer.

CALCIUM CARBIDE AND ACETYLENE, concerning which so many promises were made by the promoters of stock companies a year or two ago, are now finding their proper place as manufactured products, but it is a much less important place than was claimed for them. The Managing Director of the Acetylene Illuminating Co., of London, in a letter to "Engineering," says.

There is a tendency to go too fast in the application of acetylene, it being apparently overlooked that, to make acetylene, carbide is a necessity, and that to make good carbide, on a commercial scale, specially constructed costly machinery and apparatus are required, with experience in their manipulation. Carbide cannot be made economically on a small scale.

We do not expect that acetylene will supplant coal gas

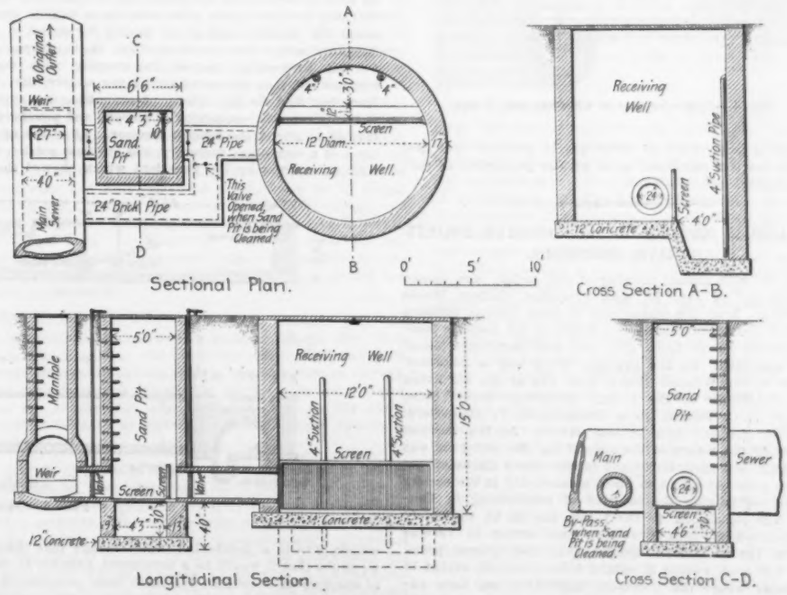


FIG. 3.—DETAILS OF RECEIVING WELL AND SAND PIT.

or the electric light in places where gas works or electric stations exist, unless the prices charged be abnormally high; but for country houses, churches, factories and villages where no gas or electrical works exist, as well as for lighting railway carriages and small railway stations, we are satisfied there is an enormous field for its use.

We have commenced making carbide at Foyers, and we have turned out ingots weighing from over 5 cwt. to over 10 cwt.

THE ALLEGED CAST-IRON PIPE TRUST has filed an answer to the petition for an injunction against it, noted in our issue of Jan. 21. It admits the existence of a protective association, but denies the distribution of an unearned bonus of $14,000,000 in 1896. The case was to be heard in the U. S. Circuit Court at Chattanooga, Jan. 25.

DEATHS FROM INHALING ILLUMINATING GAS in Boston are stated by Dr. F. W. Draper, Medical Examiner in that city, to have increased notably since the substitution on a large scale of water gas in place of coal gas. The increase is attributed to its greater proportion of carbonic oxide.

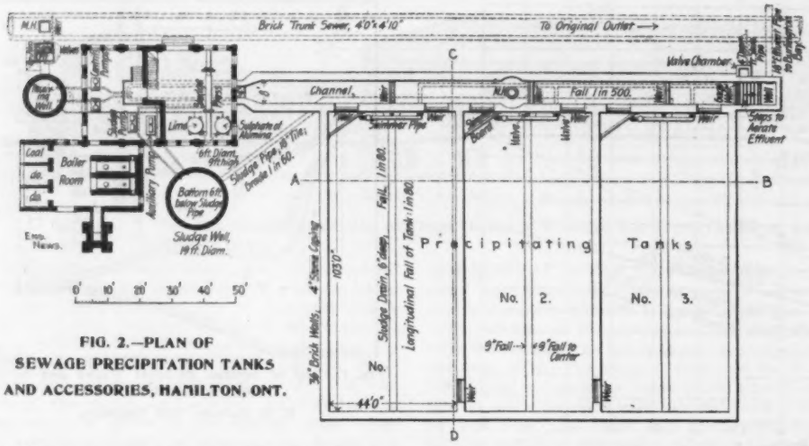


FIG. 2.—PLAN OF SEWAGE PRECIPITATION TANKS AND ACCESSORIES, HAMILTON, ONT.

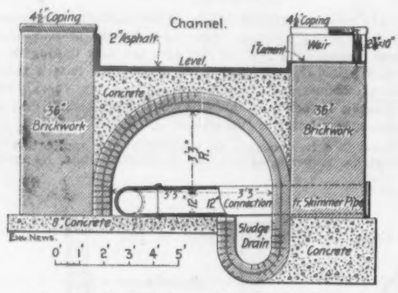


Fig. 4.—Cross-Section of Channel and Weir.

THE ANNUAL MEETING OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS.

The eleventh annual meeting of this society was opened at Montreal on Jan. 12, with President Herbert Wallis presiding. After the transaction of some routine business about 60 members visited the works of the Lachine Rapids Hydraulic & Land Co., and were there entertained at a luncheon. In the evening there was a members' dinner at the Windsor Hotel, with five of the six living Past Presidents of the society attending, these being Messrs. T. C. Keefer, John Kennedy, E. P. Hannaford, P. Alex. Peterson and Thomas Munro. At the meeting of Jan. 13 the report of the council for the past year was presented, the most important matter there discussed being the proposed action to make membership in the society legally requisite to the practice of engineering in Canada. The legislation to effect this has to be separately incorporated in each Province, and, owing to various causes, the committees appointed for the several provinces had been unable to secure definite action, except in Manitoba, where the necessary legislation has been enacted. After considerable discussion the matter was finally referred to the council with power to take such action as it deemed best for the interests of the society. The Committee on Standard Measures reported that measurements made without the stamp of the Department of Weights and Measures upon the appliances used were illegal. No sufficient means exist for the standardizing of engineering measures, and it was recommended that the department recognize such standards as might be found satisfactory for testing tapes and chains, as local standards, for the purpose of issuing authorized standards of length. It was also suggested that engineers should only be required to possess one standard, of not less than 50 ft. length, with which, from time to time, they may compare their working measures. The Gzowski Medal Committee, with Prof. Henry T. Bovey as chairman, awarded the medal for the best paper of the year to Mr. E. Mohun, of Victoria, B. C., for his paper on "The Sewerage of Victoria, B. C." The following officers and members of the council were elected for the current year: President, Thomas C. Keefer, C. M. G.; Vice-Presidents, Henry T. Bovey, William T. Jennings and William George Thompson; Treasurer, Kennet W. Blackwell; Secretary, Clement H. McLeod, Montreal; Members of Council, all the Past Presidents and Messrs. St. George Boswell, M. J. Butler, G. C. Cunningham, C. E. W. Dodwell, G. H. Duggan, H. Irwin, H. H. Keating, G. A. Keefer, D. H. Keeley, D. Macpherson, E. Marceau, M. Murphy, H. Peters, A. Macdougall, H. N. Ruttan; Librarian, William McNab. After an address by the President-elect and an address by the retiring President, Mr. Wallis, upon "The Consumpton of Coal in Locomotive Practice," the meeting adjourned.

ANNUAL MEETING OF THE AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

The third annual meeting of this society is being held this week at the rooms of the American Society of Mechanical Engineers, 12 West 31st St., New York. Sessions were held on Tuesday morning and afternoon, and others will be held on Wednesday afternoon and evening and Thursday morning and afternoon. The meeting is largely attended, about 100 members and guests having registered by Tuesday afternoon. The president, Prof. R. C. Carpenter, of Cornell University, opened the meeting with the announcement that the secretary of the society, Mr. L. H. Hart, had died the day before. A committee was appointed to frame suitable resolutions of respect, and members were invited to attend the funeral services. After the appointment of a temporary secretary, the business session began with an address by the President which showed that the society was in a flourishing condition and that there was no doubt that it would be a permanent addition to the list of engineering societies. He made some recommendations in favor of broadening the requirements for membership, so as to admit others than those actually engaged in the heating and ventilating business. He also referred to the recent progress in the art of heating and ventilating, commending especially the general introduction of mechanical ventilation and of automatic temperature regulation. He favored a revision of the constitution so as to provide for two meetings in a year instead of one. Annual reports were then presented by the treasurer and by the council and board of managers. The reports of special committees were then called for, and the committee on legislation presented a verbal report to the effect that much work had been done in correspondence with boards of health and other public officials in all the states of the country to obtain their sentiments in regard to the passage of laws similar to the Massachusetts law designed to secure proper ventilation of all schools, hospitals and other public buildings. The replies were unanimous in favor of the passage and enforcement of such laws, with one exception, in which the writer said the country was suffering from too much law now. What we wanted was less law and more liberty. After a long discussion of the question of how to proceed to obtain the desired laws the matter was postponed until Thursday, when the committee expects to bring in a written report, including a draft of a proposed law.

In the afternoon session three papers were read and discussed. The papers had been printed in advance of the meeting. Their titles were as follows:

Separation of Oil and Grease from Exhaust Steam. By W. J. Baldwin.

Methods of Proportioning Direct Radiation. By R. C. Carpenter.

Determining the Volume of Air Passing Through a Register per Minute. By J. H. Kinealy.

The discussion of all these papers was lively, and in many cases brought out ideas not mentioned in the paper. Mr. Baldwin's paper led to a discussion of the danger of grease accumulation in boilers. Prof. Carpenter's paper led to a vigorous debate concerning theory and practice. It had a formula in it, which raised the ire of one of the members who thought the use of a formula meant the use of theory, and he said that the practical man proportioned radiating surface from his experience, and that no such practical man would use a formula nor would his descendants. He said that Mr. Baldwin's rule for proportioning is good enough for him, not knowing apparently that Prof. Carpenter's formula, which is entirely an empirical one, is nothing but a rule expressed in the shape of a formula, and that Mr. Baldwin's rule has just the same amount of theory in it that Prof. Carpenter's had. The so-called "theoretical" men of course upheld the formula, which we shall give in a later issue, and the discussion showed more than anything else that many heating and ventilating engineers have great need of the elementary instruction which they will get by becoming members of this society.

The paper of Mr. Kinealy led to a discussion of different methods of measuring air supply, some of which include a large factor of guess work. Incidentally it brought up the question of how under the Massachusetts law the supply of air in public schools is determined. It was shown that in order to comply with the law and be sure of satisfying the inspector contractors have to put in about 20% more boiler and radiating surface and flue area than they think necessary. One contractor said he always put a clause in his contract to the effect that the test of his ventilating apparatus, when the gravity system of ventilating only was used, should be made on a day when the outside temperature was at least 40° colder than the indoor temperature. He said gravity ventilation was a total failure on warm days, and explained why in early spring the atmosphere in schools ventilated by the gravity system is apt to be intolerable. It would be well for school building committees to know that when they contract for a system of gravity ventilation they will get a perfect system for every day when the thermometer is below the freezing point, but that whenever the temperature outdoors rises to 50 or 60° the ventilating system will cease to act, and the children will be poisoned with bad air.

After the discussion of these three papers the list of "Topics for Discussion" was taken up; and the first one consumed the rest of the time of the session. It was, "Can Oil or Gas Fuel be Used to Advantage in Heating Dwellings?" The answers were quite varied, some speakers holding that gas was the coming fuel, and others stated that with coal at $5 per ton and gas at $1 per 1,000 cu. ft., gas fuel is ten times as expensive as coal.

We will give a report of the remainder of the sessions next week with an abstract of the papers.

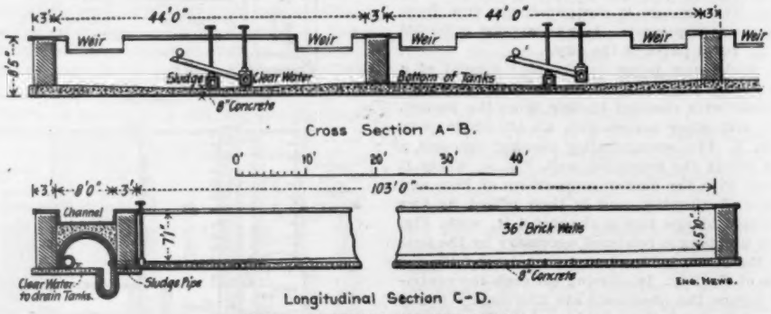


FIG. 3.—SECTIONS THROUGH TANKS.